NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XXVI.

MAY 1882 to OCTOBER 1882

> *"To the solid ground*
> *Of Nature trusts the mind which builds for aye."*—WORDSWORTH

London and New York:
MACMILLAN AND CO.
1882

LONDON:
R. CLAY, SONS, AND TAYLOR, PRINTERS,
BREAD STREET HILL, E.C.

INDEX

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, MAY 4, 1882

TONNAGE LEGISLATION

WHEN it was announced, towards the close of the year 1880, that a Royal Commission had been appointed to consider the operation of the Tonnage Law, the action taken by the Government occasioned no surprise amongst persons interested in shipping. Disputes and differences of opinion, between the officials of the Board of Trade on the one side, and shipbuilders or shipowners on the other, had been growing more and more frequent in recent years; the rapid development of shipbuilding and the introduction of new types of ships or new systems of construction making difficult the application of the Law of 1854. When that Law was passed its language was clear and unmistakable, strictly applying to the ships then built. Wood still held the first place as the material for construction, and the technical terms used by Moorsom bore special reference to wood ships, although they were not inapplicable to the existing iron ships. Ships were then of moderate size and simple construction; ocean steam-navigation was comparatively in its infancy; and the marvellous growth in dimensions, speeds, and diversity of type which has taken place in the last quarter of a century could not have been foreseen —much less provided for in framing the Tonnage Law. It will readily be seen, therefore, that controversies of opinion were unavoidable when the Act of 1854 had to be extended to modern steamships, every clause being subjected to the closest scrutiny, and a strict legal interpretation being given to phrases which were originally clear enough, but of which the modern readings were doubtful or obscure. Shipowners naturally desired to secure the minimum nominal tonnage for their ships, since dues and taxes were assessed thereon; the Board of Trade surveyors, on the other hand, while acting with perfect fairness, might be expected to adopt an interpretation of the law which tended towards a tonnage exceeding that admitted by the owner. In some notable instances of recent occurrence the Board of Trade has either had to yield to these claims for reduced tonnage-measurement, or has been beaten in an appeal to the Law Courts; and it was natural, under these circumstances, that an attempt should be made to secure such an amendment of the Act of 1854 as was needed to prevent further controversy.

Nor was this the only reason for revision. Ever since the present tonnage law has been in force for British ships there has been a tendency on the part of other maritime nations to approximate to our system of measurement. The International arrangements made in connection with the Danube navigation and the Suez Canal have been based on the Moorsom system; and at the present time there is a closer approach to a uniform system of tonnage than has ever been reached before. This desirable result has been produced to a large extent by the action of the Board of Trade, whose successive Acts for the Amendment of the Law of 1854 have been adopted in foreign countries, although they have failed to secure Parliamentary approval at home. Consequently we stand, at present, in the curious position of still having in force the earliest and confessedly imperfect edition of the Moorsom system, whereas English experience and suggestion have given to other countries amended editions. On this ground, therefore, it was desirable to revise the tonnage law, even if the system remained unchanged in principle.

Further reasons for revision of a more thorough and sweeping kind were not wanting. It was admitted that the Law of 1854 was a great improvement upon its predecessors: more scientific in its mode of measurement, and having a sounder basis as applied to the ships built when it was framed, and to the then existing conditions of trade. On the other hand, it was alleged that subsequent changes in trade and shipping rendered the operation of the Tonnage Law injurious, hampering the skill of the shipbuilder, fostering certain inferior types of ships, and favouring heavy loading. In short, it was asserted that a change of system was needed on the grounds of greater safety to life and property, and greater fairness and freedom as between different types of ships.

All these reasons for inquiry are recognised in the Instructions issued to the Royal Commission. No one can fairly complain that the field of investigation is unduly limited; and a perusal of the evidence taken by, or the documents submitted to the Commission, will show that the exponents of every shade of opinion had the greatest freedom allowed them in illustrating their views. If no other purpose had been served, the inquiry would have been justified by the very valuable summary of facts and opinions which it has been the means of putting on record. All that it is necessary to read for the full understanding of the past history of British tonnage laws can be found in the Minutes of Evidence or the Appendices; and much valuable information respecting foreign tonnage laws can also be found therein. Valuable as this feature of the work may be, however, it does not represent the purpose for which the Commission was primarily appointed, and when one turns to that aspect of the subject the results are not nearly so satisfactory.

In NATURE, vol. xxv. pp. 585-7, it was stated that the Commission did not make a unanimous Report. Three of its members dissented from the majority, and each of them produced a separate Report. This is not a matter for surprise; in fact it would not have been surprising had the Commission simply followed the precedent of the Parliamentary Committee of 1874, and submitted the evidence without making a Report. The majority consisted of nine gentlemen whose opinions are entitled to the greatest respect, including shipowners, shipbuilders, dock-proprietors, and representatives of the Board of Trade. As explained in vol. xxv. pp. 585-7, they recommend the retention of the principle of the existing law—viz. measurement of internal capacity—but propose certain amendments in detail. Some of these amendments are reasonable enough, but others are of questionable character; it is, however, of greater importance for our present purpose to consider whether the arguments advanced against a change in the principle of measurement are sufficiently weighty to prevent any change. Of all these arguments the most important are those relating to international obligation and convenience. Bearing in mind what was said above respecting the action of this country in leading up to a system of international tonnage, on the basis of internal measurement, it will be seen that an abandonment of that basis ought not to be lightly undertaken. But this fact need not bar the inquiry as to the advantages to be gained by such a change; for obviously the most thorough and exhaustive investigation would be needed, on other grounds, before the change could be made. And if after due investigation British shipowners were convinced that the change was desirable, the evidence which would convince them could scarcely fail to induce foreign maritime nations to follow our lead. The matter might well form the subject of an International Conference before final action was taken; much as was done in 1873 when the Suez Canal Regulations were framed.

Turning to the other side much more forcible arguments can be urged against a continuance of the present system. Moorsom took great pains to explain his reasons for using internal capacity as the basis of tonnage measurement; these may be summed up in the statement that internal capacity was the fairest measure of the possible earnings of most ships. This was probably the case in 1854; but is no longer true. In most ships the limit of freight-earning is now found in their "dead-weight capability"; that is to say, the prevalent cargoes of commerce do not now fill the whole space, when the weight taken on board has reached the limit of draught which can be accepted with a due regard to the safety of the ships. This is not true of all ships, but of most. Passenger ships, for instance, do not come under this condition; in them space is of the greatest value. Other types of ships, always engaged in carrying light cargoes still come under the condition which in 1854 was thought to be nearly universal. Still these cases are now the minority; and in the majority dead weight capability is the more important condition. This being so it is obviously unfair to assess the tonnage of all ships on the basis of internal capacity. In certain special classes, such as the "awning decked" class, it is alleged that the whole space available can never be filled with cargo; and on these classes the existing law bears heavily, although they are acknowledged to be eminently safe and seaworthy.

On other grounds the retention of internal capacity as the basis for tonnage is to be deprecated. Even with the amendments suggested in the Report of the Majority, there can be no hope that the disputes hitherto so frequent will cease, when a decision has to be arrived at respecting the spaces to be included in or excluded from the gross tonnage; and the deductions to be made therefrom in estimating the register tonnage. The Majority evidently realise this difficulty and attempt to meet it by more precise definitions; but the ingenuity which has been displayed in dealing with the phraseology of the Act of 1854 is not likely to fail in finding loopholes in the barriers now proposed. Nor can it be admitted that some of the proposals of the Majority are fair or foreseeing, having regard to the obvious tendencies and the possibilities of progress in shipbuilding and engineering. Into this discussion, however, it is not possible to enter here.

The three dissentient Reports contain much sharper criticism of the Majority Report than appears in the foregoing remarks. Exception has been taken to the tone of these Reports by some members of the Majority, but apparently not with much justice. Mr. Glover represents the shipowners who desire to be "let alone," and think the present Tonnage Law needs little or no change. Mr. Waymouth, accepting the view that "dead-weight capability" now rules the freight-earning of most ships, proposes to make dead-weight capability the basis of tonnage. Mr. Rothery advocates the "displacement," or total weight of the laden ship, as the fairest basis. Respecting Mr. Glover's views nothing need be said additional to what has already been stated respecting the working of the present system; but it is desirable to glance at the other proposals.

Mr. Waymouth has revived the oldest system of tonnage. "Keels" and other coal vessels were so measured time out of mind; and various empirical rules were framed for the "dead-weight capability" of other classes of ships. Being empirical they were easily evaded; Mr. Waymouth favours a well-known system of measurement, which takes account of the true form of the ship and renders evasion impossible. His system demands a fixed load-line; this is one of its difficulties. In order to overcome this objection to his scheme Mr. Waymouth favours the appointment of some central authority by which the load-line will be fixed. It is known that the Board of Trade is now taking preliminary action and ascertaining the feeling of shipowners on the subject of establishing such a central authority. If it should be formed, then the load-line question might be dealt with more satisfactorily than it has been hitherto, and one difficulty in dead-weight measurement would disappear. But others, and probably fatal ones, would remain ; more particularly in dealing with passenger steamers or vessels built to carry light cargoes. In such cases Mr. Waymouth proposes to fix, for tonnage purposes only, a deep load-line; this is not merely objectionable, but would probably be impracticable in many vessels. The dead-weight system has much to recommend it for consideration on the grounds of simplicity and exactness, as well as freedom from the difficulties incidental to internal measurement. But it is not likely to come into use.

Mr. Waymouth, it will be noted, agrees with the majority in proposing to continue the immemorial practice of basing tonnage measurement upon earnings or earning-power. This principle, although long accepted, has always been held open to question, on the ground that the accommodation provided for a ship in harbours, docks, canals, &c., should regulate the dues paid by her, and not her earnings. The "service rendered," and not the earnings, does appear the fairest basis of assessment, and has a considerable weight of authority to support it ; but to adopt this basis would clearly necessitate a settlement of the mode of appraising service rendered. Mr. Rothery proposes to take the displacement, or volume of water displaced by a ship to a fixed load-line, as the measure of this service. The load-line, he suggests, might be fixed by the owner or some central authority. To this proposal many objections have been raised; but that which seems to have most force is found in the statement that the volume of water displaced does not measure the accommodation required, since various degrees of fineness of form under water might be associated with the same extreme dimensions—length, breadth, and draught. Two ships agreeing in these dimensions and requiring practically the same accommodation might differ in displacement by as much as 50 to 60 per cent. of the smaller.

Mr. Rothery's proposal has, however, done good in recalling attention to the principle of taxation on *service rendered.* In further investigations this is not likely to be overlooked ; and it must be possible to frame some scheme which is not open to the objection to displacement above mentioned. The proposal to take the product of the three extreme dimensions of a ship as a basis for tonnage has been considered, and has much to recommend it, if associated with a fixed load-line. It cannot be said that any of these alternative schemes have received the full consideration they require before being brought forward for adoption. The investigation would necessarily be laborious, and the issues dependent upon it are so important that it should be intrusted only to competent and impartial hands. Certain conclusions are necessarily forced upon every person who makes a study of this subject. First, it is impossible in any revision of tonnage law to ignore the question of the load-line legislation. The majority of the Commission, in their final Report, propose to keep the two questions distinct; but it has been stated publicly by Mr. Waymouth that up to the very last draft Report, the majority made recommendations in the opposite direction ; and if this is the case the less weight attaches to the recommendation which actually appears. Second : in considering future legislation, both for tonnage and for load-line, greater regard must be had to the provision of stability for merchant ships than has been had heretofore. Rough "rules of thumb" for free-board, in relation to depth of hold, are out of date. Third : the work to be done must be largely dependent upon the calculations made by competent naval architects for various types of ships, and various conditions of loading. Such calculations applied to vessels which have been thoroughly tested at sea under known conditions of lading must be the foundation for future rules for load-lines. Lastly, it is much to be desired that the proposed Shipping Council should be constituted, and that it should be a central body, including all classes interested in shipping, and having behind it a staff of skilled naval architects. The Marine Department of the Board of Trade has been much abused, and probably unfairly criticised in many cases. Its action, both as regards tonnage legislation and the load-line of ships, may not have been all that could be desired, yet it must be admitted to have been well intentioned. But it cannot be supposed that the Department as now constituted is capable of dealing with the questions pressing for solution. Neither its nautical, technical, nor adminstrative staff is competent for this task. And it may be supposed that the necessary reinforcement of that staff, the valuable assistance and advice of a Council of Shipping, and the more scientific investigation of matters relating to the safety and good behaviour of merchant ships by naval architects, will be welcomed by the Board of Trade as warmly as by the shipping community. Until these further investigations are completed, amended legislation scarcely seems practicable. It is clearly impossible on the lines laid down in the Report of the majority of the Royal Commission of 1881.

W. H. WHITE

MYTH AND SCIENCE

Myth and Science. An Essay. By Tito Vignoli. International Science Series. (London: Kegan Paul, Trench, and Co., 1882.)

THIS work is devoted to a theory of myths and myth-formation, which is to some extent novel. Looking to the general, if not universal, tendency of all races of mankind to create myths, the author contends that the propensity must point to some feature of human psychology of more than a merely superficial character, and without disputing previous theories as to the origin and growth of myths, he seeks to explain the *raison d'être* of the myth-forming faculty. Thus, for instance, he says :—

> "The worship of the dead is undoubtedly one of the most abundant sources of myth, and Spencer, with his profound knowledge and keen discernment, was able to discuss the hypothesis as it deserves. . . . . Yet even if the truth of his doctrine should be in great measure proved, the question must still be asked how it happens that man vivifies and personifies his own image in duplicate, or else the apparitions of dreams or their reflections, and the echoes of nature, and ultimately the spirits of the dead."

And, speaking of Tylor, he adds :—

"He admits that there are in mankind various normal

> and abnormal sources of myth, but he comes to the ultimate conclusion that they all depend on man's peculiar and spontaneous tendency to *animate* all things, whence his general principle has taken the name of *animism*. . . . . But, while assenting to this general principle, which remains as the sole ultimate source of all mythical representation, I repeat the usual inquiry; what causes man to animate all the objects which surrounds him, and what is the cause of this established and universal fact?"

And elsewhere the author states this problem thus:—

> "To attain our object, it is necessary that the direct personification of natural phenomena, as well as the indirect personification of metaphor; the infusion of life into man's own shadow, into reflex images and dreams; the belief in the reality of normal illusions, as well as of the abnormal hallucinations of delirium, of madness, and of all forms of nervous affections; all these things must be resolved into a single generating act which explains and includes them."

Such being the problem with which the work is mainly concerned, its solution is attempted by the following theory:—Assuming the fundamental identity of human and brute psychology, it is argued *a priori* that, seeing the tendency to personify inanimate objects is so universal among primitive men, we might expect to find a similar tendency in animals, and this, according to the author, we do find:—

> "Animals are accustomed to show such indifference towards numerous objects, that it might be supposed that they have an accurate conception of what is inanimate; but this arises from habit, from long experience, and partly also from the hereditary disposition of the organism towards this habit. But if the object should act in any unusual way, then the animating process which, as we have just said, was rendered static by its habitual exercise, again becomes dynamic, and the special and permanent character of the act is at once revealed."

And he proceeds to describe many experiments of his own, in frightening or surprising animals by making inanimate objects perform unusual movements. From these considerations and experiments he concludes that every object of perception is "implicity assumed" by an animal to be "a living, conscious, and acting subject;" that the animal transfuses into all things, "in proportion to the effects which result from them, his own nature, and modifies them in accordance with intrinsic form of his consciousness, his emotions, and his instincts."

This being taken as true of animals, the theory proceeds to the consideration that if we superimpose on the animal faculties of sensation and perception, the distinctively human faculties of reflection and symbolic thought, we should obtain a full explanation of the psychology of myth-formation.

We have said that this theory is to some extent novel, and it will now be seen that the extent to which it is so consists in its relegating to the domain of animal psychology that tendency to animism which has already been recognised as the feature in human psychology which is largely concerned in the formation of myth. But even thus far the theory is not wholly novel, for Comte supposed that animals possessed some crude ideas of fetishism, and Spencer, in his "Principles of Sociology," says:—

> "Holding, as I have given reasons for doing, that fetishism is not original but derived, I cannot, of course coincide in this view; nevertheless I think the behaviour of intelligent animals elucidates the genesis of it;"

And he proceeds to detail cases which he has himself observed of "the idea of voluntary action being made nascent" in animals upon their seeing or feeling inanimate objects moving in unaccustomed ways. This, we think, is the whole extent to which the observed facts of animal intelligence entitle us to go. Uniformity of experience generates in animals, as in young children, organised knowledge of animate and inanimate objects, so that they are always more or less prepared with some antecedent expectation of the manner in which this or that object will behave. When, therefore, an inanimate object begins to move in some unaccustomed manner, the animal becomes alarmed, and no donbt "the idea of voluntary action becomes nascent."[1] But to argue from this fact that "every object, every phenomenon is for him a deliberating power, a living subject, in which consciousness and will act as they do in himself," and consequently that to animals the whole world "appears to be a vast and confused dramatic company, in which the subjects, with or without organic form, are always active, working in and through themselves, with benign or malignant, pleasing or hurtful influence"—to argue thus is surely to go far beyond anything that the facts either warrant or suggest. The very consideration that an animal shows alarm and horror when an inanimate object begins to behave like an animate one, points to the conclusion that he has made a pretty definite mental classification of objects as animate or inanimate. Therefore, without going further into the matter, it seems to us that the attempt made by this writer to argue for an universal animism as a feature of brute psychology, is a failure.

Of more interest and sounder theory is the part of his work which treats of the connection between Myth and Science. He says:—

> Man, by means of his reduplicative faculty, retains a mental image of the personified subject, which is only transitory in the case of animals, and it thus becomes an inward fetish, by the same law, and consisting of the same elements, as that which is only extrinsic. These phantasms are, moreover, personified by the classifying process of types, they are transformed into human images, and arranged in hierarchy, and to this the various religions and mythologies of the world owe their origin. Since such a process is also the condition and form of knowledge, the source of myth and science is fundamentally the same, for they are generated by the same psychical fact"—*i.e.* that of ideally classifying objects of perception—"the historical source of the two great streams of the intellect, the mythical and the scientific, is found in the primitive act of *entifying* the phenomena presented to the senses"—in the one case with the conception of personality, and in the other with that of natural order.

This idea of myth and science having a common root in the rational faculty of man is not, of course, a profound one, seeing it is obvious that myth, like science, arises from the need or desire of reason to *explain* the facts of nature which are everywhere obtruded upon the observation of "the thinking animal"; but it is perhaps well that this truth should be clearly stated, as it is in the work before us. We think, however, that here, as indeed throughout, the work is needlessly protracted.

GEORGE J. ROMANES

---

[1] See NATURE, vol. xvii. p. 168 *et seq.*, where this subject is treated at more length.

A PRIMER OF ART

A Primer of Art. By John Collier. (London: Macmillan and Co., 1882.)

IN this admirable little work Mr. Collier has succeeded in bringing clearly into view the helpful relation in which science may stand to the Arts of Design—sculpture, drawing, and pre-eminently painting. The aim of the primer is to give the outlines of such knowledge of the artistic field of vision, of the visual powers, and of the means of delineation, as may best aid the student to acquire that power of strict imitation of natural objects which is the artist's first qualification.

The notion hitherto prevailing and perhaps somewhat superciliously held to on the part of art—that because the primary functions of science and of art respectively are widely different, therefore no legitimate help can be rendered by one to the other—is practically discredited in every page of Mr. Collier's little work. Throughout, his object is to pioneer the student to an artistic goal; throughout, the means employed have all the security of clear scientific principle. The theory of the Primer is that by knowing with scientific accuracy how some things *are*, the task of exhibiting artistically how other things *appear* may be greatly simplified.

After devoting a few charming pages to the latest suppositions concerning the origin of sculpture and drawing—pages illustrated by specimens of prehistoric and even palæolithic art—Mr. Collier quits "debateable ground" for that on which surer scientific light can be shed for the guidance of the student in the practice of art.

And here nothing is overlooked. Boundaries, Light and Shade, Texture, Perspective, Colour, and Contrast are the headings of so many terse and luminous little chapters, through each of which comes some word to the learner from the invisible world where science works, warning him how, unless he gives heed to certain hidden actualities within and without him, he may and probably will go many times wrong before he lights on the best way of rendering the natural objects before him.

Accurate seeing is necessary to ensure accurate delineation. The *facts* of simple appearance are what the art student needs to lay hold of. Science, whose constant business is with facts of every order, aids him here with suggestions how to discriminate between sight and inference—between that actual aspect of an object which is due to its present relation to the sight of the observer, and that compound mental view of it which is due to the mixed memory of many previous aspects. A perusal of Mr. Collier's pages on the nature of perspective, on the undulatory theory of light, on the action of a lens, on the structure and nervous mechanism of the eye, and on the physiological rationale of the phenomena of colour show how much scientific information can be given without the use of a single technical phrase.

Having learnt to see, the art student must further learn to delineate. Here again, in discussing the painter's media, it is still with the authority of science the teacher speaks. The chapter on "Turbid Media" clears up the difficulty respecting the varying behaviour of pigments as used on different "grounds." Here, too, as elsewhere, each practical suggestion is accompanied by a scientific reason why the means advocated should be adopted, such reason being always backed by some absolutely lucid explanation of the *nature* of the difficulty to be surmounted, or of the effect to be aimed at.

With the subject of landscape painting comes up the question of aërial perspective; and thereupon follow some admirable pages on the constitution of the atmosphere and the refraction of light. In dealing later with certain necessary discrepancies between natural appearances and their painted imitations, Mr. Collier clears out of the way, by a simple scientific consideration, an insidious problem with which the artistic beginner is apt needlessly to perplex himself—namely, how correctly to represent effects of light and shade within the very limited range of luminosity afforded by his materials. The solution lies within the sphere of optics. The eye takes next to no heed of the degree of total illumination; the *absolute* luminosity of the picture therefore does not signify. All that is needful is to render the *relative* proportions of light and shade in the object or scene depicted; the effect will then be accurate, since sight adapts itself readily and unconsciously to any *scale* of illumination that may be visible at one time.

For the rest, this little work of Mr. Collier possesses all the attributes of a first-rate primer. As we have observed, it is terse, clear, simple, instructive, and alluring. While the student receives aid from various departments of knowledge, calculated at once to forward his progress in painting, and to enrich his ideas of the world in which he works, there is nothing attempted to which the finished artist—aware as he is of the part played by imagination and by an incommunicable sense of harmony in the production of the finest art-work—can yet take any exception. Mr. Collier frankly admits the limitations of science with regard to these points, and leaves untouched all vexed questions concerning harmony of line and colour, on the ground that, important though they are, too little is known about them to make discussion profitable.

Yet that there is no real antagonism between accurate knowledge wherever it can be had, and the loftiest artistic imagination, and further, that science may help to free that imagination by giving it mastery over its means of expression, are truths borne witness to throughout the eighty-eight pages of the primer. The scientific reader will recognise in Mr. Collier's successful endeavour to link the rival sisters (Art and Science) in friendly partnership for the better portrayal of that Nature of which both are students, a welcome sign of the times, and an indication of the direction in which we may look for firmer ground than has hitherto been found for fruitful artistic discussion.

L. S. BEVINGTON

OUR BOOK SHELF

A Treatise on Rivers and Canals. By L. F. Vernon-Harcourt, M.A. Vol. I. Text, 352 pp.; Vol. II. Plates, 21 Pl. (Oxford: Clarendon Press, 1882.)

THIS work was intended (see Preface) to present "in a simple and concise form descriptions of the principal and most recent works on rivers and canals, and the principles on which they are based." It appears to have had its origin in a course of lectures delivered at the School of Military Engineering, Chatham, in 1880, but has been so carefully revised as to be free from the defects of a mere reprint of a lecture course, and may be fairly said to fulfil well the object proposed in the preface. Great pains has evidently been taken to obtain data of actual examples of important works within the above scope; the series of twenty-one well-executed large plates of these is a most valuable feature of the work. The get-up of the work, being issued from the Clarendon Press, is of course excellent; the number of folds in the plates is an inconvenience (few have less than six, and one has ten folds), which might have been obviated by placing fewer diagrams on each plate. A very useful feature is the addition at the end of each chapter of a short summary of its matter, with many good practical remarks.

The work opens with a chapter on the physics of the subject, followed by one on discharge-measurement, then by one on general principles. Then come seven chapters on various appliances and details, viz., dredgers, piling, foundations, locks, inclines, lifts, fixed and movable weirs, dams, and movable bridges. Then follow one chapter on inland canals, one on great ship canals, one on protection from floods, four on improvement of tidal rivers, and lastly, one on the improvement of the mouths of tideless rivers.

From the great variety of subjects treated of in a compass of 322 pages, the treatment is sometimes unequal. The descriptions of the newest forms of the various appliances are, together with their illustrative plates, very interesting and instructive. But perhaps the most valuable part of the whole work is the last five chapters on the difficult and important subject of the improvement of river mouths; the few guiding principles that can be said to be known about so obscure a question are well brought out from the study of grand examples. The subject of discharge-measurement is not adequately treated: a reference to the recently-published (1881) "Roorkee Hydraulic Experiments" would probably have materially influenced this chapter in giving less importance to current-meters, and more to floats (especially tube-rods), and in the entire rejection of the old Chézy formula, $V = C \times \sqrt{RS}$, with a *constant* value of C. The chapter on inland canals is also (perhaps unavoidably) sketchy: thus the description of Indian canals covers only two pages, many of them being simply named.

ALLAN CUNNINGHAM

Galeni Pergamensis de Temperamentis et de Inæquali Intemperie Libri tres, Thoma Linacro Anglo Interprete, 1521. Reproduced in exact Facsimile. With an Introduction by Joseph Frank Payne, M.D. (Cambridge: Macmillan and Bowes.)

THE book before us is one of a series of facsimile reprints of eight books, published in the years 1521–22, by John Siberch, at the first press established at Cambridge; and it would appear, that after the issue of this series, no other works were published there until the year 1585, when a law was passed, limiting the printing of books to London and the Universities.

The revival of classical literature which swept over Europe towards the close of the fifteenth century, effected a complete revolution in the theory of medicine, as well as in philosophy. English scholars of that period were, as a rule, unacquainted with Greek, the few exceptions being men who had studied at the Italian Universities; among these was Thomas Linacre, a Fellow of All Souls, Oxford, who, about the year 1495, visited Italy in the suite of Selling, when the latter was appointed envoy to the Pope, and, after being a fellow student with the sons of Lorenzo de Medici, under Politiano and Chalcondylas, proceeded to his degree of Doctor of Medicine at Padua. On his return to England, he brought with him the reputation of being one of the most elegant and accurate scholars of the day. Shortly afterwards he was appointed tutor to Prince Arthur, and became Court physician on the accession of Henry VIII. to the throne. The physicians of the day were mostly ecclesiastics, but no restriction was placed on the practice of medicine by persons, however ignorant of its principles; and Linacre, with the view of remedying the abuses that prevailed, devoted his fortune, amassed by the sale of the clerical livings to which he had been presented, to the foundation, in the year 1518, of the Royal College of Physicians, which, under its charter, had power to regulate the practice of medicine in the neighbourhood of London. It is interesting to know, that according to Linacre, a physician should be "a grave and learned person, well read in Galen, respecting but not bowing down to the prestige of the Universities; claiming for his own science a dignity apart from, but not conflicting with that of theology; looking upon surgeons and apothecaries with charity, and not without a sense of his own superiority."

The Galenical theories of humours and temperaments formed the groundwork on which the Greeks based their practice of medicine, and Linacre to bring these theories within the reach of all students of medicine translated into Latin six of Galen's works, among which were the "De Temperamentis" and "De Inæquali Intemperie," now before us, thus helping to replace the mysticism and empiricism of the Arabians by the accumulated observations recorded by Hippocrates and Galen. In these works it is assumed that to the four humours, blood, pituite, yellow bile, and black bile, there are the corresponding properties, moist-heat, moist-cold, dry-heat, and dry-cold; and that between health and disease there are four temperaments, characterised by an excess of either one or two of the cardinal qualities, heat, cold, moisture, and dryness. These were the only external influences acting on the body the ancients could recognise, as they were ignorant of the chemical processes of respiration, of the constitution of the atmosphere, and of electricity, of which we now take account. These theories are elaborated, and further, it is indicated that medicines may be classified according to their heating, drying, cooling, or moistening qualities, and should be administered so as to temper the errors of the humours in disease; and though the work has ceased to have a practical value for physicians, it yet remains of interest to the student of humoral pathology, and of the philosophy of the middle ages.

Students are indebted to the enterprise of Messrs. Macmillan and Bowes for the reprint of this scarce work, which was the first book containing Greek characters printed in England, and we are glad to learn that the same publishers propose shortly to issue the remainder of the series. The book is edited by Dr. J. F. Payne, and is prefaced by a portrait and an admirable life of Linacre.

Rhopalocera Malayana: a Description of the Butterflies of the Malay Peninsula. By W. L. Distant. (London: W. L. Distant, care of West, Newman and Co., 54, Hatton Garden, E.C.)

WE have received the first part of this handsome work, in which it is proposed to describe and figure all the species of butterflies which inhabit the Malay Peninsula and the islands of Penang and Singapore. Forty-four coloured figures of butterflies are given in this part, occupying four plates of large quarto size: and they are most admirably executed in chromo-lithography. Some of the figures, indeed, are hardly to be distinguished from good hand colouring. The descriptions are full and careful, and much judgment is shown in using, as far as possible, old and well-established names, and in rejecting needless sub-divisions of the genera. It is expected that the work will be completed in six or seven parts, forming a handsome quarto volume; and we trust that the author may obtain numerous subscribers in our wealthy colonies of Singapore and Penang, as well as at home, to encourage him to complete the work in the same full and careful manner as he has commenced it.

As most of the butterflies of the larger Malay Islands must be studied in comparison with those of the Malay Peninsula for the purposes of his work, we would suggest to Mr. Distant that he would add greatly to its value to all European collectors if he would give, in a supplementary part, a complete synopsis of the known species of butterflies inhabiting the Indo-Malayan region. Having figured all the continental Malayan species, the descriptions of those of the islands might be, in most cases, by comparative characters, aided occasionally, perhaps, by outline woodcuts. We believe that such an extension of the scope of the work would double its value, and add largely to the list of subscribers; while the increased expenditure would be comparatively unimportant.

A. R. W.

Conic Sections Treated Geometrically. By S. H. Haslam, M.A., and J. Edwards, M.A. (London: Longmans, 1881.)

THIS is a neat little treatise on the conic sections, containing—what appears to be a novelty—a method of *plane projection*, to which the authors give the name of *Focal Projection*. The remarkable feature of the book is, that the authors, who are evidently well up in these curves, should not be acquainted with the writings of the present master of St. John's College, on the same subject. No one who has looked into Dr. Taylor's recent works, could be unacquainted with what he has said upon the contributions of Boscovich and G. Walker, and would hardly use the "generating circle" of a conic in the same fashion as Boscovich does, and write, after the definition, "which we have called the *auxiliary circle of a point*."

Schwatka's Search: Sledging in the Arctic in Quest of the Franklin Records. By W. H. Gilder. Maps and Illustrations. (London: Sampson Low and Co.)

THIS is the complete record of the expedition sent out by private subscription, in 1878, under Lieut. Schwatka, to endeavour to find the records of the Franklin expedition, which were reported to be in possession of the Nechelli Eskimo. With the general results of the expedition, our readers have already been made acquainted. The reported records, as might have been expected, were never found. But in and around the Fish River, and in King William Land and neighbourhood, several relics were obtained, and several graves and cairns found. The expedition, indeed, completed the story of the sad disaster of the *Erebus* and *Terror*. During the search, sledge-journeys of upwards of 3000 miles were made, and thus much welcome additional information was obtained concerning the country between Hudson's Bay and King William Sound. The expedition came a good deal into contact with the Eskimo, concerning whom Mr. Gilder has much to tell us. The narrative is interesting, and is welcome as throwing additional light on an Arctic expedition in which Englishmen have always continued to be interested. There are a number of good illustrations.

Chambers's Etymological Dictionary of the English Language. A new and thoroughly revised edition. Edited by Andrew Findlater, M.A., LL.D. (Edinburgh: W. and R. Chambers, 1882.)

THIS little work, since the publication of the first edition, edited by the late Mr. James Donald, has had deservedly a very extensive circulation. It is just the book to have at one's elbow for constant reference, handy, clearly printed, fairly full, and thoroughly trustworthy. This new edition has evidently been so thoroughly revised by Dr. Findlater, as to be virtually a new work. The selection of words has been made with great discrimination, the definitions are clear and comprehensive, and the etymologies up to the latest results of linguistic research. The dictionary contains a large number of scientific terms, though there are one or two others that we think ought to have found a place. The dictionary is the best of its class; the appendix contains much useful information, including a table of the Metric System.

Tunis; The Land and the People. By the Chevalier de Hesse-Wartegg. (London: Chatto and Windus, 1882.)

HERR VON HESSE-WARTEGG spent some months in Tunis last year, and has made a readable book out of his notes. He has also drawn largely on other sources of information, so that those who know little about a country which has been so much before the public recently, will find some useful information in this volume. The author spent a good deal of time about Tunis and its environs, but seems also to have visited several other places in the Regency, including, apparently, Kairwan. He tells us a good deal about the people and their customs, about the government, the Bishas, antiquities, &c. There are several good illustrations, but no map.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Silurian Fossils in the North-west Highlands

ON my return to-day from a geological tour in the North-west Highlands, I read with much interest the letters of Mr. Hudleston and Prof. Bonney on the above subject. The question as to the geological position of the limestone series in West Ross-shire, correlated by Murchison with the Durness limestone, is one to which I devoted special attention during my late visit to the neighbourhoods of Lochs Carron, Doule, Kishorn, and Maree. The general appearance of the limestone in these areas is sufficiently like that of Durness to lead to the supposition that it is of the same age, but this of course can only be proved by fossil evidence. The conclusion at which I have arrived, however, in regard to the geological position of the limestone, and as to its relation to the so-called Upper Gneiss rocks of the central parts of Ross-shire, is in direct opposition to the views of Murchison, and accords in the main with that of Prof. Nicol. The great triangular patch at the head of Loch Kishorn consists of a series of thick beds of grey limestone, with a few bands of sandstone in an unaltered condition, and is undoubtedly dropped by faults amongst much older strata, as maintained by Prof. Nicol. Between Lochs Carron and Doule the same series is seen to rest unconformably upon much higher beds than those which it is supposed by Murchison and others to underlie at Loch Kishorn. As I purpose shortly to give a full account of these researches, I will not venture now to trespass further on your space.

HENRY HICKS

Hendon, N.W., April 29

Earthquakes and Mountain Ranges

IN NATURE of the 27th ult., in a note on a recent meeting of the Seismological Society of Japan, it is mentioned that the observations of Prof. Milne "as far as they have at present gone, show in a remarkable manner how a large mountain range absorbs earthquake energy." It may be worth while to mention, as an exception to this, that the Swiss earthquake at 1 p.m. on July 25, 1855, which apparently had its origin among the mountains on the south side of the Valais, between Visp and S. Nicholas, both of which places were seriously damaged, travelled through the Bernese Oberland, across the great valley of Switzerland, and then through the Jura. I was at the time in a small inn, at a place called Belle Rive in the Munster Thal, on the north side of the Jura. The house was severely shaken, so that some plaster fell from the ceiling. This was about seventy-five miles from the place of origin, and the wave in that interval had passed through two mountain ranges. It is probable that this earthquake was caused by a disturbance of a quite different kind from the volcanic disturbances of Japan, and that may account for a difference in the result.

O. FISHER

Vivisection

THE editor of NATURE has no room for proofs; I must, therefore, confine myself to statements of facts which "A Student of Medicine" can verify by consulting the books I shall name.

Prof. Schiff is the author of several works detailing an enormous number of vivisections. Some six years ago the "Gazetta d'Italia" calculated that, of dogs alone, he had used in his laboratory 14,000—supplied to him gratuitously by the municipality of Florence—besides great numbers of other animals otherwise procured. Afterwards he received only about eight dogs a week from the police, and, in consequence, posted up an advertisement offering a franc for every dog brought to him, and a *bonus* upon ten dogs brought by one person. In the "Physiologie de la Digestion" he says: "I am forced to cut the vocal cords of the greater number of my dogs, lest their nightly howlings should compromise my physiological pursuits."

In Prof. Schiff's "Lezioni di Fisiologia Sperimentale" will be found ample justification of my statements with regard to the character of the vivisections performed by him. I regret much that there is no room to quote examples here. It will be observed by the reader of these "Lessons of experimental physiology," that the nature and duration of the majority of the experiments render the administration of chloroform either impossible, or at the best, utterly inadequate to hinder suffering. The animal is either *distinctly sensible* throughout the experiment, or has been already operated on some days previously, being preserved in a mangled and paralysed condition for further experiment.

As regards the "anæsthesia," I have to-day questioned a medical graduate, who resided seven years in Florence while Prof. Schiff lived there, and was constantly in his laboratory. He says that, although chloroform was commonly administered on tying down the animals (he believes. for the convenience of the operator), no pretence was made of keeping them under the influence of the anæsthetic after the preliminary incision, and that—as in fact is conclusively proved in Prof. Schiff's own works—mutilated animals were reserved from day to day, and from week to week, for further investigation.

If since leaving Florence and publishing his "Lessons" Prof. Schiff has mended his ways, I am sincerely glad to hear it. Should such, indeed, prove to be the case, public opinion at Florence—which ran high against him and his doings—must be credited with some share in the reformation.

In conclusion, let me say in regard to the discourteous charges of "error," "ignorance," and disregard of "facts" so freely brought against me by your correspondent, that if in this case any person is amenable to them, it is certainly not one who, being perfectly acquainted with the works both of Prof. Mantegazza and of Prof. Schiff, bases her estimate of their performances on *their own explicit statements*. ANNA KINGSFORD

11, Chapel Street, Park Lane, W., April 14

[MRS. KINGSFORD's letter was forwarded to our correspondent in Geneva, who sends the following reply:—]

In reply to Mrs. Kingsford's letter, I have the following remarks to offer:—

1. If Mrs. Kingsford is "perfectly acquainted" with the works of Prof. Schiff, she must know that there exists a small book in which he has explained in detail his methods of vivisection, &c. The title is: "Sofra il metodo seguito negli esperimenti sugli animali viventi nel laoratorio di fisiologia di Firenze." It first appeared in 1864; the second enlarged edition bears the date 1874. The book is written in a popular style, so as to render it easy even for the uninitiated to understand what vivisection is, and how it is practised by Prof. Schiff; it should be read by every person desirous of forming an unbiased judgment on the subject.

2. My letter was a reply to the accusation brought against Prof. Schiff of perpetrating "horrible tortures," "atrocities," &c. The *number* of dogs used for experiments (which number is erroneously stated), and the price supposed to have been paid for them are evidently irrelevant to the question. Moreover, you will find stated on p. 53 of the above pamphlet, that Prof. Schiff never accepted a dog unless its owner assured him that he would otherwise kill it himself; and I can corroborate from personal recent experience here in Geneva the further statement in the same passage, that if a person likely to be a kind master offers to take one of his dogs, he is always ready to give it away.

3. I regret to find that Mrs. Kingsford allows herself to misquote. The passage in the "Physiologie de la Digestion" referred to is on p. 291 of vol. i.: "Je suis *obligé* de faire subir la section des *nerfs laryngés à beaucoup* de nos chiens." The section of the vocal cords is a dreadful operation, that of the nerves in question so slight, that if performed on dogs whilst at their meals, they do not leave off eating! To this I can testify. Moreover, you will notice that Schiff says, "Je suis *obligé*," and the fact is he was *forced by the police* in Florence to cut the nerves in question; not indeed on most of his dogs, but on those which were not used for vivisection properly so called, but were kept during long periods for other (and perfectly painless) observations, such as those detailed regarding the very dog mentioned in that lecture (see the 13th lesson, p. 325).

4. People not versed in physiology are not competent to draw conclusions from a work such as the "Lezioni di Fisiologia sperimentale." Mrs. Kingsford herself offers an example of how gross the errors are into which they may fall when she declares that in the majority of experiments the administration of anæsthetics is either "impossible or inadequate." On p. 70 of the pamphlet "Sofra il metodo," &c., Schiff says: "Nello stato attuale delle nostre conoscenza non existo *un solo esperimento* praticato nell' animale viventi, al qualo non si possa, e quindi non si debba, togliere il carattere di crudeltà mediante l'uso degli anestetici;" and lower down: "Da 25 anni non mi sono *neppure una volta* veduto nella necessità di escludere l'uso degli anestetici." On p. 52 he writes: "Brediamo dover aspettare finchè ogni traccia di sensibilità, e l'effetto meccanico delle sensazioni sia scomparso."

5. To the medical graduate's statement and insinuations I oppose Prof. Schiff's affirmation and my own knowledge of his character and scientific habits. It is curious that this gentleman, after having spent seven years in Prof Schiff's laboratory, should be ignorant that *chloroform* is *never* used by him (see p. 49).

6. That many animals which have been operated upon are kept alive for ulterior observations is expressly stated in my first letter, and any person, however ignorant of science, can understand that whole branches of physiology can only be studied under the condition of this being so. They are kept not only as Mrs. Kingsford so pathetically exclaims, "from day to day, and from week to week," but sometimes from year to year." The question at issue is whether they suffer or not, a question easy to decide by their appearance, appetite, and demeanour. And the fact is they *do not suffer*, a statement any one can corroborate who chooses to come and look at the dogs in the School of Medicine here. *Why* they do not suffer is explained in detail in the pamphlet referred to above.

7. Prof. Schiff has *not*, alas, "mended his ways in deference to public opinion;" he tells me that never since the year 1847 has he departed from the methods detailed in the book quoted at the beginning of this letter.

Geneva, April 23 B.SC., STUDENT OF MEDICINE

Red Variable Stars—"Variab. Cygni (Birmingham), 1881," &c.

THE above star, so called by Schmidt in the *Astr. Nach.*, No. 2421, is now a striking object of 8 magnitude. On December 21, last year, it was certainly not over 12, and, probably, it was less. This appeared about its minimum, and its maximum seemed to have been attained on June 6, when it was 8 mag., as at present. On May 22, when I first found it, it was about 9. If it is now at maximum, there must be a striking inequality in its periods of decrease and increase, but perhaps it will go on to a greater magnitude this time than before.

U Cygni (No. 553 in my Red Star Catalogue) seemed last night (April 28) to be smaller than I ever saw it previously, and under 11 mag. Its colour was, however, very marked. The blue star near it (Arg. +47° 3078), which I have long considered to be slightly variable (see Catalogue), seems now at a maximum of 8 magnitude, though contrast with its diminished neighbour, may have some effect on its apparent size.

No. 448, in which I have also detected variability, is now about 8·5, and as deeply coloured as when I first found it in April, 1876. J. BIRMINGHAM

Millbrook, Tuam, April 29

Matter and Magneto-electric Action

THE very interesting lecture by Mr. Spottiswoode on the above subject incidentally throws light upon a phenomenon which probably has puzzled some other of your readers besides myself.

When a somewhat weak current is passing between the knobs of a Becker-Voss electro-induction machine, its passage can be altogether stopped by simply blowing across the path of the current. The handle is turned in vain; and even when the blowing has ceased, a short time is required before the current is able to pursue its old path. When the instrument has been warmed, and the current becomes stronger, the blowing, although now unable to stop the current altogether, drives it into irregularly curved paths, which are determined by the force exerted. I do not remember to have seen the experiment mentioned in any book. It is as curious as it is simple.

We now see why the air requires to be at rest for the weak current to force a passage through it, and to keep that passage open for the succeeding sparks to follow; while the stronger current leaps from point to point, as though in pursuit of the warmed and opened passage which has been driven by the wind out of its former position.

HENRY BEDFORD

All Hallow's College, Dublin, April 15

CYCLONES[1]

SINCE it first became known that a considerable proportion of the storms which visit this part of Europe come from the middle and northern parts of North America, the meteorology of that country has been invested with a peculiar and increasing interest for the inhabitants of Western Europe, and though, according to Hoffmeyer, the chance that a depression in the United States will subsequently cause a storm somewhere in our own islands is only one in four, it is a ratio quite substantial enough to make us regard with attention warnings such as those transmitted to us through the medium of the *New York Herald*.

While America is thus from her enormous size and westerly position enabled to act the part of our weather prophetess, she bids fair in addition to leave us far behind in the more theoretical branches of weather-science, and though to admit this may be somewhat wounding to our national *amour propre*, it is nevertheless an idea which is openly entertained by some of our leading meteorologists. For our comfort it may be reasonably ascribed, in part at least, to our small size and unfavourable geographical position having afforded but little encouragement to really able men to devote their attention to a science whose operations are conducted on a scale compared with which our area of observation is indeed microscopic, so that until within quite recent times the succession of fair and foul weather in these islands was regarded merely as a series of irregular, eccentric, and totally unpredictable changes. The work before us, entitled "Methods and Results," by Prof. William Ferrel, of the American Coast Survey, and prepared for the use of the coast pilot, forms the second part of a series of meteorological researches undertaken by the author, which comprise an elaborate theoretical investigation into the general and local mechanics of the atmosphere. In Part I., which appeared in 1877, the general motions of the atmosphere are more particularly dealt with, and conclusions are arrived at which have appeared in part in the *Mathematical Monthly* for 1860 and the *American Journal* for November, 1874.[2]

In both these publications the author lays great stress upon the important part played by the deflecting force to the right of its path, to which a current of air is subjected by virtue of the earth's rotation *in whatever direction it may be blowing*. This deflecting force is measured by the acceleration $2n \cos \psi$, where n represents the angular velocity of terrestrial rotation, and ψ is the co-latitude (see NATURE, vol. v. p. 384).

With the assistance of this element he theoretically deduces in Part I. the general motions of the atmosphere, which agree with what is known from observation. He also makes considerable use of this same principle, which he was the first to enunciate correctly, when dealing with the theory of cyclones in Part II. As we propose just now to confine our attention to Part II., which treats mainly of cyclones, we shall not refer to Part I. except incidentally. Part II. is sub-divided into three chapters, the first of which deals with the mechanical theory of cyclones, and deductions therefrom. In Chapter II. the results of the theory are compared with those of observation, and Chapter III. treats of tornadoes, hailstorms, and waterspouts. The chief elements considered in the theory of cyclones are (1) the earth's rotation, (2) the gyratory velocity round the low centre, (3) the friction, (4) the inertia, and (5) the temperature and humidity of the air.

These elements are all discussed in turn, and many important conclusions drawn from the resulting equations. Some of these conclusions have already been either directly deduced by the employment of analogous methods, or inductively inferred from an examination of data, by Guldberg and Mohn, Colding, Peslin, Sprung,[1] Clement Ley, Hildebrandsson, Meldrum, Loomis, and Toynbee. Some however are quite new, especially those which are derived from a consideration of the temperature term.

The general theory of the cyclone, according to Ferrel, may be briefly stated thus:—

If from any initial cause interchanging motions are set up between the air in a certain district and another surrounding it, the air in the first district tends to gyrate round its centre by virtue of the deflective force of the earth's rotation, and in the same direction as that of the component of terrestrial rotation, which acts in the plane of its horizon. In the northern hemisphere this would mean gyration contrary to watch-hands, and in the southern hemisphere gyration with watch-hands. In the outer district the gyrations of the air, by the principle of the preservation of areas (or moments), are contrary to those of the interior district. These two systems of contrary gyrations tend to draw the air from the centre of the inner district and the exterior limit of the outer district, and heap it up in the place where the gyratory velocity vanishes and changes sign, thus causing a maximum barometric pressure there, with corresponding minima at the centre and outer limit respectively.

In addition to this, when the gyrations have once commenced they give rise to a centrifugal force which tends to drive the air still more from the centre of the inner district, and so increase the barometric depression there; but which in the outer district, partly owing to its distance from the centre, and partly to the small velocity of the gyrations, has but little effect on the distribution of pressure. The gyrations, especially near the centre and exterior limit, would be very rapid, were it not for the friction between the air and the earth's surface, which retards the motion, but does not entirely prevent it, since, as the author very pointedly remarks, "without some such motion frictional resistance would not be brought into action." So far we have only considered the gyratory component of motion, and as in the imaginary case of no friction, this would be the only kind of motion, the gyrations might then be entirely circular. When, however, as actually happens in the atmosphere, friction acts, a radical component becomes necessary, since the deflecting force is now partly employed in counteracting the frictional resistance to the gyrations, and the magnitude of this radial component (on which depends the inclination of the wind to the isobar), varies *cæteris paribus* directly with the amount of friction.[2] As a result of the two

---

[1] "Methods and Results of Meteorological Researches for the use of the Coast Pilot." Part II.—On Cyclones, Waterspouts, and Tornadoes. By William Ferrel. (Washington, 1880.)

[2] "Relation between the Barometric Gradient and the Velocity of the Wind," by W. Ferrel, Assistant U.S. Coast Survey.

[1] "Die Trägheits-curven auf rotirenden Oberflächen," *Zeitschrift für Meteorologie*, Band xv., January Heft, 1880.

[2] This result is best seen in the following expression for the angle of inclination of the wind to the isobar $\tan i = \dfrac{f}{2\left(n \cos \psi + \dfrac{s \cos i}{r}\right)}$, where f is the coefficient of friction, s the velocity of the wind, and r the dis from the low centre.

tendencies—gyration and inflow, or outflow according as the air is in the interior or exterior part—the air near the surface takes a middle course, and flows spirally around and toward the centre from the zone of maximum pressure on the one side, and on the other in a contrary spiral outwards from the centre to the outer limit of the anticyclone.

It is important to observe that the author explains the accumulation of air with its maximum at the dividing line between the interior and exterior districts (cyclone and anticyclone, as they are termed elsewhere throughout this work) as "due at the start mostly to the gyrations in the *upper* part of the atmosphere," which, being less influenced by friction, are in consequence more circular than those below; the pressure from this accumulation tending to force the air near the earth's surface out from beneath it on the one side toward the centre of the cyclone, and on the other toward the outer limit of the anticyclone.

The difference of pressures or gradient between the regions of high and low pressure in a cyclone, is thus shown to be, not so much the *cause* of the wind, as the mechanical result of the deflecting force of the earth's rotation and the centrifugal force engendered by the gyrations.

It should, however, be borne in mind, that the forces just mentioned, are by no means to be regarded as causing the cyclone in the sense of being *independent* sources of energy. They can only arise in consequence of some initial motion of the air, which must itself be due to a small difference of pressure, and unless such primary disturbing cause be continually maintained by external influences, the entire system of motion will shortly come to rest.

The preceding view of cyclone generation has already made some way since Ferrel first enunciated its leading characteristics in his previous writings. It lies midway between what is sometimes called the in-blowing or ascension-current theory of Reye and Espy, which regards the central depression as the main cause of the wind, and that held by Thom, Meldrum, Willson, and Loomis, according to which the central depression is mainly due to the centrifugal force generated by two pre-existing currents passing one another in opposite directions. A third theory, held by Blanford and Eliot, and evolved chiefly from a study of the cyclones in the Bay of Bengal, makes the condensation of vapour the *primary* cause of disturbance, but allows the greater part of the *subsequent* depression of the barometer to be due to the causes adduced by Ferrel. This latter theory, in fact, only differs from that put forward by the author in the part played by condensation of vapour in giving rise to the initial motion of the air, which Ferrel considers to be considerably less than that exercised by a difference of temperature. Among the conclusions arrived at by the author, and which are generally confirmed by the results of observation, may be noticed the following; but these, it must be remarked, are only strictly true for a regular, symmetrical, and stationary cyclone:—

(*a*) "The wind inclines towards the centre from the direction of the tangent, and the amount of inclination is nearly in proportion to the friction (mainly of the air against the earth's surface)."

(*b*) "The inclination diminishes with the altitude, and therefore at some distance from the earth's surface the gyrations are more circular than near it."

(*c*) "Toward the centre of a cyclone, where the gyratory velocity is greater, the inclination is less, and therefore the path more nearly circular."

(*d*) "The inclination increases with decrease of latitude, attaining its greatest value at the equator, where the air should flow directly towards or from the centre, and there should be no gyrations."

(*e*) "As the motion of the air below in cyclones is *toward* the centre, in the upper regions of the atmosphere it must be nearly circular, but inclined to the tangent a little *from* the centre."[1]

Inertia comes into play where a cyclone is increasing or diminishing in violence, and its effect is to increase the inclination in the former case and diminish it in the latter, but in general the amount is found to be insignificant.

It was stated in the above brief sketch of the theory, that outside the annulus of high pressure surrounding a cyclone the air should move outwards anticyclonically. Ferrel subsequently puts the matter thus: "*Every cyclone is accompanied by a corresponding anticyclone, and the former cannot exist without the latter.*"

The words cyclone and anticyclone are here used quite apart from the question of barometric pressure, and simply mean districts in which the motion of the air is spirally in towards the centre, or out from the centre respectively. Guldberg and Mohn likewise adopt this definition, which is obviously far more scientific than the too common habit of referring to them as regions of low and high pressure.

Mr. Ferrel, however, differs from all previous investigators in thus linking together the cyclone and anticyclone as mutually dependent parts of the same phenomenon. They have hitherto been treated separately, at least in practice, and though the author's conclusion sounds like a simplification, because it makes *one* out of *two*, we scarcely think he has proved the converse to his proposition, viz. that every anticyclone is accompanied by a *corresponding* cyclone, and cannot exist without it.

For example, in the case of such an anticyclone as every winter forms over Central Asia it would be difficult to point out exactly its corresponding cyclone or cyclones, though it is possible, as the author says, that it may be partly due to the overlapping of the anticyclones, which should surround the permanent North Atlantic and Pacific cyclones at this season.

The relation between the barometric gradient and the velocity of the wind in a symmetrical cyclone is given by the following equation:—

$$G = \frac{1076{\cdot}4(2n\cos\psi + \nu)s}{\cos i(1 + {\cdot}004\,t)}\,\frac{P}{P'},$$

where $\nu = \frac{s\cos i}{r}$, and G is the gradient in millimetres per sixty geographical miles, s the velocity of the wind in metres per second, n the earth's angular velocity of rotation per second, ψ the co-latitude, i the inclination of the path of the wind to the isobar, $P\,P^1$ the barometric pressure at the given elevation and at the earth's surface respectively, t the temperature in degrees Centigrade, and r the distance from the low centre in kilometres. Where the gradient is given, the velocity of the wind can be conveniently found from the equation

$$S = -\tfrac{1}{2}a \pm \sqrt{\tfrac{1}{4}a^2 + bG},$$

where, if the ordinary English units of space and time are used, viz. a mile and an hour, and the gradient is expressed in inches per sixty geographical miles, we have—

$$\begin{cases} a = \dfrac{0{\cdot}52505\,r\cos\psi}{\cos i} \\ b = \dfrac{r(1 + {\cdot}004\,t)}{{\cdot}005262}\,\dfrac{P}{P'} \end{cases}$$

The equation for the gradient in terms of the wind's velocity is substantially the same as that already given by the author in *Silliman's Journal* for 1874, with the exception of the temperature correction, which was there simply referred to in the text.

As the whole question of the author's formula for the gradient has been thoroughly ventilated in his previous

---

[1] This conclusion only applies to districts within a moderate distance from the centre. At great distances from the centre the radial component predominates, and the air flows nearly directly towards the centre below, and from it above.

works and in the *Zeitschrift für Meteorologie* (Band x.), we need not notice it here except to point out that, assuming the correctness of the formula, the gradient, *cæteris paribus*, should vary (1) directly with the latitude, (2) inversely with the distance from the centre, (3) inversely as the temperature, (4) directly with the amount of inclination.

The foregoing results have all been obtained without considering the term depending on temperature and humidity, and which expresses the effect of the disturbing force necessary to start and maintain the interchanging motions between the interior and exterior portions of the air over a given area. That such a disturbing function is necessary, is evident both from preliminary considerations, and also from the form of the general equations of motion, since they would otherwise be satisfied by the conditions for a state of *rest*. The author enunciates this principle in Part I. Chap. III. where he says: "*There can be no winds then without a disturbance of the static equilibrium by means of a difference of temperature or of aqueous vapour in different parts of the atmosphere.*" And it is important to bear it in mind, if only because we are too often apt to overlook it in the multitude of secondary causes brought to light by a study of atmospheric mechanics. A consideration of this term, in which temperature and humidity are treated jointly, and the former is *assumed* to vary with the distance from the centre, leads to the remarkable conclusion that there are two species of cyclones, one with relatively *warm* centres, the more common case, and the other with relatively *cold* ones.

These cyclones differ specifically from each other chiefly in the way in which the pressure is distributed and the gyrations directed at different altitudes.

In a cyclone with a relatively warm centre the air at the earth's surface moves in a cyclonic spiral round and towards the centre, but as we ascend the gyratory velocity diminishes with the altitude, and the annulus of high pressure approaches the centre, until at a very high elevation the highest pressure of that stratum might even be at the centre, and the air gyrate anticyclonically from it over the whole area at that level. In brief, the cyclonic area becomes smaller, and the anticyclonic larger, as we ascend.

In a cyclone with a cold centre the reverse occurs. At the surface of the earth the initial tendency of the air is to move outwards, and this may be so strong near the surface that there may be only anticyclonic gyrations at this level, with the maximum pressure of the *lowest* stratum at the centre. As we ascend, however, the gyrations round the centre become more and more cyclonic, while the annulus of maximum pressure gradually retreats further and further from it.

There is, besides, according to the theory, an *ascending* motion of the air in the interior part of a warm-centred cyclone, and a descending motion in the exterior part, both generally *small* in comparison with the horizontal motions toward and from the centre. In the case of a cold-centred cyclone these motions are reversed.

Now as a barometer at the earth's surface records simply the integrated effect of what happens in all the strata up to the top of the atmosphere, this might obviously vary in the *same* way for both kinds of cyclones, and so tell us absolutely nothing of such remarkably diverse conditions prevailing at higher altitudes. The behaviour of the air in the warm centred cyclone is what we are accustomed to observe in the case of *most* cyclones, and as they are as often found with relatively *cold* centres as with *warm* ones, the former occurring more frequently in *summer* and the latter in *winter*, it is difficult to understand why the characteristics of the cold-centred cyclone have never yet been found to prevail, at least in moving cyclones. The author indeed offers an explanation of this circumstance, and endeavours also to account for the absence of stationary cold-centred cyclones in regions like Central and Eastern Asia and North America in winter, where the temperature gradient would be remarkably favourable to their production. The fact, however, that in the centres of these regions at this season there is not only no cyclonic tendency of the winds or depression of the barometer, but, on the contrary, a pressure greatly above the normal, seems strangely at variance with what we should expect according to the theory of the cold-centred cyclone, and is hardly satisfactorily explained away as the result of the irregularity and size of the area, combined with the excessive *cold*, which latter is supposed to increase the density and pressure more than the cyclonic tendency diminishes them. The only two cases of cyclones with cold centres which the author seems able to find are the two general wind systems of the northern and southern hemispheres respectively, which "are simply two great cyclonic systems with a cold centre, having the cold poles of the earth for their centres. The motion of the air eastward around and toward the poles in the middle latitudes, giving rise in those latitudes to the normal south-west winds in the northern, and north-west winds in the southern hemisphere, form the cyclones, and the trade-wind region the corresponding anticyclones, with the equatorial calm-belt for the common limit of the two systems. The tropical calm belt and corresponding maxima of barometric pressure near the parallels of 30°, correspond to the similar calm and dividing line between the cyclone and anticyclone in the ordinary and smaller cyclonic systems."

The primary cause of cyclones, according to Ferrel, is a *horizontal temperature gradient*, so that if a portion of the atmosphere is heated or cooled more than the surrounding parts, and the isotherms are approximately circular, we have the initial conditions for a cyclone; but after the disturbances due to such primary causes have set in, secondary causes depending on loss of heat by expansion in ascent, and gain of heat by compression in descent, as well as retardation of cooling where aqueous vapour is being condensed, come into play, which *on the whole* tend to counteract the initial motions.

The condition of the atmosphere *vertically* with respect to temperature and humidity, is thus of great importance in regard to the duration of a cyclone when it has once started.

The author investigates this point at some length, and works out the conditions for cyclone generation in quite a novel manner, from a consideration of both vertical and horizontal temperature gradients. Generally speaking, the condition most favourable to the maintenance of an ordinary cyclone is that the vertical temperature decrement in the interior should be less than in the surrounding regions. This condition is found to be more easily sustained where the air is charged with aqueous vapour, since under these circumstances it cools less rapidly in ascending than when dry. He further points out that where the decrement of temperature in the interior is less than outside, especially when this condition occurs throughout the entire atmosphere, a cyclone may arise without any horizontal temperature gradient (provided only a small instantaneous impulse be given), and that such a state of *unstable equilibrium* more readily occurs when the air is warm and saturated with vapour. While, however, he thus admits the important *rôle* played by vapour in maintaining cyclonic action when once started, he distinctly denies its claim to be considered "*either a primary or principal cause of cyclones.*"

As these islands in all probability seldom, if ever, form the birthplace of a cyclone, but we are rather accustomed to experience them either fully developed or else in the condition of being "filled up," the circumstances which attend their generation do not practically very much concern us. Still it must not be overlooked that conditions which would tend to create and maintain a cyclone in our midst, must of necessity tend to augment the violence of a storm arriving on our coasts, so that if meteorology, or that branch of it termed weather forecasting, is ever to become an exact science, we must endeavour to find out, by captive balloons or otherwise, what can never be determined by registration at the earth's surface alone, viz. the condition of the atmosphere *vertically* as regards temperature and humidity.

The author concludes his theoretical investigation into the mechanics of cyclones by a discussion of the causes of their motion over the earth's surface. He first of all shows that every cyclone possesses an inherent force tending to urge it towards the pole of the hemisphere in which it has been formed. This follows immediately from the fact that the deflecting force due to the earth's rotation varies with the cosine of the colatitude, and is therefore greater on the polar than on the equatorial side of a cyclone, a residual poleward component of force being thus brought to bear upon every portion of the cyclone. In addition to this, a cyclone, as soon as it is generated, must partake of the general motions of the atmosphere, which the author more especially deals with in his "Meteorological Researches," Part I., to which we have already made allusion; and since the general motions of the atmosphere are there considered to form two great cyclonic systems round the poles, all ordinary cyclones are simply cyclones within a cyclone, so that their general motion of translation is partly the result of the actual motion of the air in these large and perpetual, though perpetually changing, cyclones, and partly that of their inherent tendency to *press polewards*.

For example, as the author says, "in the trade-wind latitudes the wind at the earth's surface is westward . . . and hence the cyclones in these latitudes are carried westward, . . . and having a tendency towards the Pole, the resultant of the two is a westward motion, inclined a little towards the poles, or in the northern hemisphere a motion about west-north-west. After having arrived at the parallel of 30° or 35° in the tropical calm-belt, where there is no westward motion, the progressive motion is a Polar one mostly, but after progressing still nearer the Pole, into the middle and higher latitudes, the general eastward motion of the atmosphere here, which is great in the upper regions, carries now the cyclone toward the east, and the direction of the progressive motion, which is usually about east-north-east, is the resultant of this eastward motion and the motion round the Pole. All well-developed cyclones, therefore, having their origin near the equator, have mostly a progressive motion represented by a curve somewhat in the form of a parabola, having its vertex in the tropical calm belt at the parallel of 30° or 35°."

It is moreover shown that the general motions of the atmosphere must not only cause the cyclone to travel more or less with them, but also affect the inclination of the wind to the isobars, decreasing it in the front, and increasing it in the rear part.

With regard to further modifying causes, the author favours the views of Clement Ley regarding the effect of the distribution of aqueous vapour in determining the direction in which a cyclone propagates itself.

He does not indeed attempt to explain how they sometimes wander off on an entirely unlooked-for course, or else remain stationary for some considerable period; otherwise he might claim to have at least attempted a solution of the entire problem on which weather science depends. Clement Ley himself, in his admirable little work,[1] recently published by authority of the Meteorological Council, tells us that the reason why the course of a cyclone cannot be exactly foretold is because "in the first place the causes which determine the course of depressions are not fully known; in the second, place so far as they are known, it is certain that the course of depressions is generally related *to the distribution of pressure over a very large area*." In fine before we know how the *small* cyclones are going to behave, we must in every case know the *form* of the larger cyclones round whose centres they travel.

E. DOUGLAS ARCHIBALD

(*To be continued.*)

THE GIZZARD-CONTENTS OF SOME OCEANIC BIRDS

THE following results of the examination of the gizzards of twenty sea-birds, which were caught by the officers of this ship in the South Atlantic and Southern Indian Oceans during the last quarter of 1881, may be of interest to some of the readers of NATURE.

With one exception all the birds belonged to the Petrel family—the Procellaridæ—and fifteen of them were of the well-known species -the Cape-pigeon or Cape-petrel (*Daption capensis*). The most frequent of the gizzard-contents of these twenty birds were the mandibles of a cephalopod, which were found in eighteen instances; the otoliths of some small osseous fishes occurred in five instances; and some curious stony masses, varying in weight from half a grain to five grains, were obtained also in five instances. The other substances, which were observed less frequently, were the vertebræ of a fish, feathers, Velellæ, the horny rings probably of some crustacean, and a small hard seed.

With reference to the seed just mentioned, I should observe that it was taken from the gizzard of a Cape-pigeon, about 550 miles to the east of Tristan d'Acunha, in the South Atlantic. The wide range of this species of petrel is well known; we ourselves first observed this bird rather to the southward of the island of Trinidad, which lies about 600 miles off the coast of Brazil; and thence we traced it as far as the island of Amsterdam, in the southern portion of the Indian Ocean. From our own observation, therefore, it is quite possible that a seed might be transported from Trinidad to Amsterdam, notwithstanding that these islands are from five to six thousand miles apart; and Mr. Mosely's surmise (*vide* a footnote in Mr. Wallace's "Island Life," p. 250) that various species of Procellaria and Puffinus may have played a great part in the distribution of plants, and may to some degree explain the similarity in the mountain floras of widely distant islands, would appear to receive some support from the single instance of this seed. With regard to the kind of plants to which the seed belongs, Mr. Moore, director of the Botanic Gardens, Sydney, kindly informed me that it possessed no character sufficiently distinctive to enable him to decide as to its probable source.

The stony masses found in the gizzards of five of the birds, all of which were caught in the South Atlantic, were of two kinds: one of the masses was of a dark colour and homogeneous texture, and rather porous; when heated it gave off black fumes with a smell of burnt organic matter, and was fusible with soda into a black glass; the other masses had the appearance of greasy quartz, scratching glass with ease; but when heated in a closed tube they blackened and evolved black fumes with a powerful odour of burnt animal matter; after the incineration they became white, and with the blowpipe were fused into a white glass after the addition of soda; no effervescence was exhibited on the application of an acid. The behaviour of these masses under heat is very similar to that described by Mr. Darwin in his "Geological Observations," in the case of a stony incrustation on St. Paul's Rocks, deposited, as he considered, from water draining through birds' dung.

H. B. GUPPY

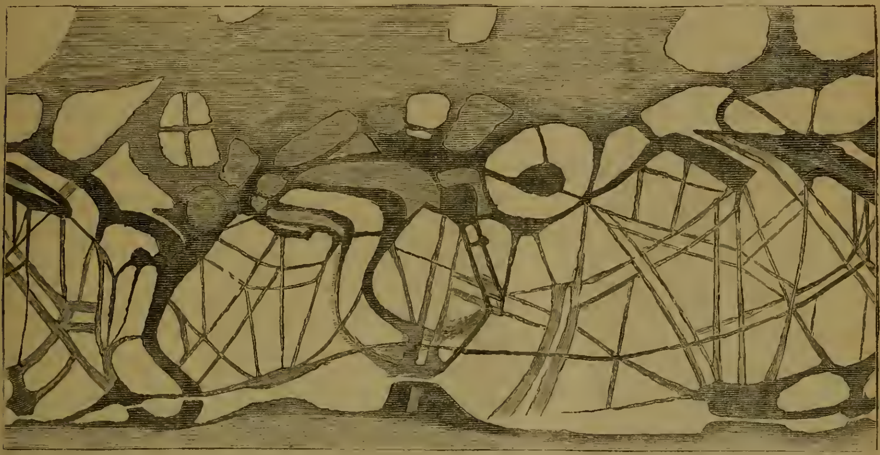
H.M.S. *Lark*, Auckland, February 28

---

[1] "Aids to the Study and Forecast of the Weather," by W. Clement Ley, M.A., 1880.

RECENT DISCOVERIES IN THE PLANET MARS

AN intended article, of which an announcement appeared in NATURE a few weeks back, on the topography of Mars as delineated for the second time by Prof. Schiaparelli at Milan during the opposition of 1879-80, has been anticipated and in part superseded by information which has been received relative to the more recent discoveries made by him in the beginning of the present year. Pending the preparation of a fuller and more detailed memoir, he has published a preliminary notice, read before the Academia dei Lincei on March 5, and accompanied by a photographed drawing of the planet's surface. The results are of a very remarkable and unexpected character; and as through the courtesy of this distinguished observer, the notice and photograph have been placed in my hands, I am induced to reproduce the latter, which, though not pretending to minute accuracy (the original, in fact, is only a provisional sketch), will give a sufficient idea of the marvellous duplication of the so-called "canals," which, between January 19 and February 24, in about twenty instances, unfolded itself progressively under the observer's eye. The discussion which took place at the late meeting of the Astronomical Society, so far as my information extends, substantiated strongly by independent evidence the existence of these long, narrow streaks, some of them even in positions where they have not been delineated by Schiaparelli; but their duplication by similar and parallel lines does not seem to have been elsewhere noticed. Some difference of opinion may possibly be expected concerning these strange appearances; and the consequent enfeebling (to say the least of it) of the long-admitted terrestrial analogy may be, to some minds, unacceptable; but the established reputation of the observer demands at any rate a respectful attention to his statements. It may be preferable to suspend a more detailed account till we receive a full elucidation of the subject in the memoir, of which we possess only a preliminary notice; for the present it may suffice to mention that he found the atmosphere of Mars apparently clearer than in 1877, and was thus enabled to recover the markings then detected more satisfactorily even than in 1879-80, and to confirm the general accuracy of his two earlier charts; while the concise, but very clear intimations that he has given, as to the variable brightness of some great regions, the progressive enlargement on one side since 1879 of the "Kaiser Sea" (his Syrtis Magna), the brightening of certain supposed continents or islands towards the limbs, the confirmed existence of oblique white streaks, the unfolding of minute labyrinthine detail, and the continuous development already mentioned, day after day, of the collateral lines which double the so-called "canals," and extend with them ordinarily along great circles of the sphere—all these and similar announcements make us anxiously desire a more extended and detailed communication. For some of these most remarkable appearances parallels may be to a certain extent produced from the results of earlier observers; but, so far as at present appears, the duplication stands alone. The discoverer is disposed to infer a connection between these progressive developments and the seasons of the planet, and on that account hopes that, owing to the position of the axis at the ensuing opposition at the opening of 1884, notwithstanding the diminished diameter (only 12″·9), confirmation of his announcements may be obtained from other observers. We sincerely trust that a report which has reached us may be verified as to the erection of a much larger telescope in the Royal Observatory at Milan, and that the extraordinary talent and diligence of the director may be richly rewarded, not only by the confirmation but the extension of results which must so materially influence our conclusions as to the physical condition of this peculiarly interesting planet.



T. W. WEBB

THE CAUSE OF TUBERCULOSIS

THE first step in the rational treatment of every malady is obviously the recognition of its cause, and it is this recognition which enables medical men to do battle against disease. It is a truism to say that as regards infectious maladies the knowledge of their cause is an essential step in preventing their spread and arresting their ravages. The malady known as tuberculosis, and generally characterised by constitutional disturbance associated with the production of minute nodular new-growths in the various organs, especially the lungs, spleen, lymphatic glands, serous membranes, the membranes of the brain, liver, &c.—[at first greyish and transparent, but afterwards becoming opac and degenerating into a yellowish-looking *débris*, and hereby implicating and destroying the organs in which they are located]—has been shown to be an infectious malady communicable from one human being to another, from man to animal, and from animal to animal.

The successful experiments of inoculating with, feeding on, and causing to inhale human tubercular matter, carried out on the lower animals, such as guinea-pigs, rabbits, dogs, pigs, &c., by Villemin, Dr. Wilson Fox, Mr. John Simon, and Dr. Burdon Sanderson, but especially by Cohnheim and Salomonsen, Tappeiner, and Baumgarten are conclusive in these respects. Similarly it has been shown that the tuberculosis of cattle or Perlsucht is communicable not only within the species but also to other animals. Whether Perlsucht is also communicable to man, especially through meat and milk, as is maintained by some observers (Semmer, Baumgarten, and others), is as yet an open question, and, as must be obvious to every one, one to which fearful importance is attached, considering how great the distribution of this disease is in the bovine species. What the cause of the malady is, has until now been undetermined, although it has been at various times surmised that, like other infectious diseases, it is of a parasitic origin. Thus Schüller, and especially Klebs, have tried to prove that owing to the presence of micrococci in the tubercular deposits, these micrococci were the materies morbi. And indeed Klebs maintains to have succeeded in cultivating outside the body of an animal, *i.e.* artificially the "monas tuberculosum," as he calls the said micrococcus, and to have again produced the tubercular disease by inoculating animals with this purified micrococcus. Klebs' observations and conclusions have not been accepted as reliable, and it has been reserved for Dr. Koch to discover the real cause of the disease, in identifying it with a specific bacillus. In a weighty paper, "The Etiology of Tuberculosis," published in the Berlin *Klin. Wochenschr*, 1882, No. 15, Dr. Koch sets forth the whole course of his investigation, the methods and experiments, all his observations and definite conclusions on this question, and anyone who peruses carefully this paper will come to the conclusion that Koch's results are to be accepted with unconditional faith, and I have no manner of doubt will be considered by all pathologists as of the very highest importance. To those who are familiar with Dr. Koch's previous work, especially that on the etiology of splenic fever or Anthrax, and his observations on pathogenic Bacteria, this last work of his, on the Etiology of Tuberculosis, will be an additional and brilliant testimony to his ingenious and successful method of research.

The first step in the inquiry was to ascertain whether any definite form of microphyte is constantly present in the tubercular deposits. This question could not be solved by the ordinary methods of research, but with new methods; it was decided in the affirmative. For the demonstration of the presence of the specific bacillus—which Koch calls the tubercle-bacillus—the following method proved successful: Tubercular deposit fresh, or after hardening with reagents, is stained for twenty to twenty-four hours—at a temperature of 40 Centigrades, only half to one hour is required—with a half per cent. solution of methylene blue, to which a small quantity of a 10 per cent. solution of caustic potash is added. After this, the tubercular material is stained for a minute or two in a concentrated watery solution of vesuvin. and then washed in distilled water. When examined under the microscope, all elements of the tubercular deposit, such as cells, nuclei, fibres, and granules, appear of a brownish colour, while the tubercle-bacilli alone stand out very conspicuously in a beautiful blue tint.

By this method Koch ascertained the constant presence of the specific bacillus in the tubercular eruption in man and animals, including the Perlsucht of cattle, both in spontaneous tuberculosis, as well as artificially produced, *i.e.* by inoculation. These bacilli differ from all other micro-organisms by characteristic properties.

The next step in the inquiry was one of essential importance in determining the nature of the bacillus as the materies morbi, viz. to isolate by successive cultivations outside the animal body, the tubercle-bacilli, and having thus completely freed them of all parts of tissue of the tubercular deposit to introduce them into the system of suitable animals. If these animals became afflicted with typical tuberculosis, and if at the same time similar animals kept under precisely the same conditions, but not infected with the bacilli, remained perfectly normal, it will be admitted that the exact proof has been given that the bacilli constitute the cause of the tubercular malady.

All these conditions have been fulfilled by Dr. Koch in an eminent degree.

The tubercle-bacilli were successfully cultivated outside the body of an animal. Pure serum of blood of sheep or cattle is sterilised by keeping it exposed in test-tubes plugged with cotton wool, for six days daily for one hour, to a temperature of 58 centigrades. After this the serum is heated for several hours up to a temperature of 65 centigrades; by this it is transformed into a solid perfectly transparent mass, well adapted for the cultivation of the tubercle-bacilli. Such serum inoculated on its surface under special precautions with tubercular matter of any source—tuberculosis of man or animal, spontaneous or artificially produced, and kept at a temperature of 37 or 38 centigrades (*i.e.* about blood-heat) for over a week, becomes gradually covered with peculiar dry scaly masses; these masses are the colonies of the specific tubercle-bacillus.

A minute particle of this crop is used for establishing a second similar cultivation, this again for a third, and so on. Tubercle-bacilli obtained in this manner, after several successive generations, prove as effective in inoculating animals with typical tuberculosis as fresh tubercular matter.

All animals susceptible to the malady that Koch inoculated with these artificially cultivated bacilli, became invariably affected with the disease; not one escaped; while other similar animals kept under precisely the same conditions, except that they did not receive any tubercle-bacilli, remained perfectly healthy.

It is important to notice that the tubercle-bacilli require for their growth and multiplication a temperature of at least 30 centigrades, and, consequently, they are limited to the animal body, unlike the bacillus that produces splenic fever or anthrax, which is capable of multiplication at ordinary temperatures, as low as 20 centigrades, and even less.

The expectorated matter of tubercular patients is generally charged with tubercle-bacilli, and these often contain spores. And it is probably through the presence of such spores that that matter retains for a long time its infective properties. Koch made experiments on guinea-pigs with such sputa after having been kept dry for fourteen days, for four weeks, and for eight weeks, and he found that in all instances the sputa had retained their full virulence. It is therefore just to assume that such sputa, even when dried on linen, clothes, or even distributed with the dust of the room, may be a source of infection.

The practical importance of the discoveries of Koch must be patent to everybody. In the recognition of the tubercle-bacilli as the *fons et origo* of this terrible pest of the human race—according to statistics quoted by Koch one-seventh of all deaths being caused by tuberculosis—in the recognition of the presence of these bacilli in the sputa of tubercular patients, and in the tubercular deposits of cattle afflicted with Perlsucht, we have at once become supplied with the knowledge of the most common manner of how tuberculosis may and probably is spread, as well as with the weapon of combating the most fertile sources of infection. In preventing the distribution—either by proper disinfection, or by destruction—of the expectorations of tubercular persons, and further, in superintending and restricting the use of tubercular animals of the bovine species, we possess the means of preventing the spread of this deadly and terrible plague, and hereby saving a vast amount of human life. These discoveries of Dr. Koch were made entirely through experiments on living animals. E. KLEIN

DEEP-SEA EXPLORATION

IN NATURE, vol. xviii. p. 348, we described Negretti and Zambra's Patent Deep-Sea Standard Thermometer. Some uncertainty as to the accuracy of its indications in deep sea service led to a re-arrangement of the instrument, which now greatly increases its reliability. The improvement is chiefly due to suggestions furnished by Commander Magraghi (see NATURE, vol. xxiv. p. 505) (of the Royal Italian Navy) to Negretti and Zambra. Several of these improved thermometers may now be fastened on one line, and serial temperatures at any required depth obtained with certainty.

FIG. 1.

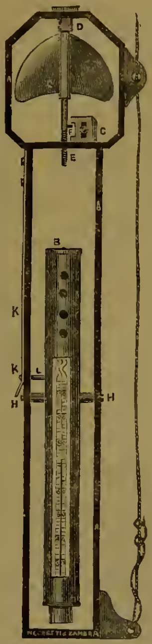


FIG. 2.

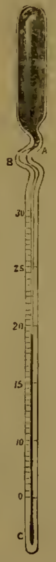


FIG. 3.

The woodcuts exhibit the apparatus, Fig. 1, as prepared for lowering down into the Sea, and Fig. 2 after the hauling up has commenced—the thermometer having reversed and registered the temperature at the moment of turning over. Fig. 3 shows the peculiar construction of Negretti and Zambra's inverted thermometer used in their improved deep-sea apparatus. The apparatus will be understood by reference to figures (Nos. 1 and 2). A is a metal frame, in which B, the thermometer, is pivoted upon an axis, H, but not balanced upon it. C is a screw-fan attached to a spindle, one end of which works in a socket, D, and at the other end is a screw, E, about half an inch long, and just above it is a small pin, F. On the spindle G, is a sliding stop-piece, against which the pin, F, impinges when the thermometer is adjusted for use. The screw, E, works into the end of the case, B, the length of play to which it is adjusted. The number of turns of the screw entering the case is regulated by means of the pin, F, and stop-piece, G. The thermometer and its case is held in position by the screw, E, and descends into the sea in this position—as Fig. 1; the fan, C, not acting during the descent, because it is checked by the stop, F. When the ascent commences, the fan revolves, raises the screw, E, and releases the thermometer, which then turns over and registers the temperature at that spot. When the hauling-up has caused the thermometer to turn over, a spring at K forces the pin, L, into a slot in the case B, and clamps it (as seen in Fig. 2) until it is received on board, so that no change of position can occur during the ascent from any cause. The case, B, is cut open to expose the scale of the thermometer, and also perforated to allow free passage of the water.

SOME PRIMITIVE IDEAS ON METEOROLOGY

IN an article published in NATURE (vol. xxv. p. 82) on the opinions of the Chinese Emperor Khang-hi on certain natural phenomena, it will be remembered that the *yang* and *yin*, or the male and female principles of Chinese philosophy, played a conspicuous part. Japan, it is well known, adopted at a very early period in its history the law, polity, science, philosophy, and writing of the Chinese, and with them the *yang* and *yin*; and it may not be uninteresting to our readers to see how the doctrine of these dual forces, mutually repellent as well as attractive, has been employed to explain the facts of meteorology. A recent issue of the *Japan Gazette* newspaper of Yokohama contains the translation of a work written in 1821 by a certain Arai Yoshinari, called the "*Ten-chi-jii*; or, Ideas about Heaven and Earth." The heavens, the writer says, are very high, the earth is very thick; we cannot ascend to the one or go down into the other; consequently man was unable for many generations to comprehend the phenomena of either; but now the opinions of all philosophers on this subject are based on the action and reaction of the male and female, the active and passive principles of nature upon each other. The rain is a changed form of the male, and the vapour under the earth of the female principle. When the male principle sinks into the earth it pursues the female. The earth is the mother of all things and the heaven is the air or wind where the sun, the moon, and the stars hang shining. There are two kinds of air—the heaven-air and the earth-air. The motion of the heavens is contrary to that of running water. The heavens move from east to west, while water runs from west to east. In some districts, indeed, water in the earth runs towards the north, but meets the earth-air which obstructs its flow, causes much agitation, and finally its complete evaporation from the surface of the earth. The vapour thus formed ascends and becomes clouds, which are again turned into rain by the action of the wind. The water has periods of increase and decrease according to the male and female seasons; thus in summer, which is the male season, water increases, while in winter, or the female season, it diminishes. Again, the earth-air is changed into rain when it moves from east to west; and therefore, previous to rain, we see a white vapour in the morning ascending in the east. "This is a clear proof of the earth's growing hot." For the same reason mountains become somewhat darker just before rain.

Thunder is produced by the mingling of the male and female principles. Sounds are often heard in the earth in the neighbourhood of volcanoes. This is due to the irritation of the earth-air, which sometimes sends out flames. It is said that a kind of beast accompanies the thunder, and it moves about in the air. This is nothing strange, because at a certain island called Ampon, which is about 3900 *ri* (1 *ri* = 2½ miles) from Japan, there is a bird called the *Kasubara*, which is covered with fur instead of feathers, and which eats fire. Other birds live on wind. As this world is unlimitedly great and extensive there may have lived strange beasts and birds, like the thunder beast which the Japanese talk about. The volume of sound given out by thunder depends on the number of water-clouds in the air. When the latter is small, the sound of the thunder is not loud and appears far off. On the other hand when the clouds are piled up in the heavens, the sound is loud and is simultaneous with the lightning. The sound is caused by the passage of fire through the water. The ancients regarded thunder as the report of the battle between fire and water—the male and female elements. If this were the case there is no reason for the interval between the flash and the sound. Earthquakes are subterranean thunder; the noise is caused by the rush of water which has long been kept confined by the earth-air. Snow is the vapour which rises from the earth; when it ascends high enough it becomes frozen and falls as snow. Fog is also this vapour. Haze is the vapour mixed with smoke from some volcano. The writer concludes by expressing his intention of making the actions of nature, such as rain, wind, &c.—difficult as they are to explain—quite clear on a future occasion.

These ideas may be taken as representing those of most educated Japanese of half a century ago, with the exception perhaps of a few who had been taught by the Dutch. What the Japanese peasant thought, and still thinks of thunder, earthquakes, storms, and other striking natural phenomena will be found in a deeply interesting chapter of Mr. Griffis's "Mikado's Empire." One of the principal Japanese artists, Hokusai, some of whose works have recently been given to the English public, did not think it beneath his genius to endeavour to picture the extraordinary creatures that form the zoological mythology of Japan. There the astonished student of Japanese pictorial art can behold Futen, the wind demon, Raiden, the creator of thunder, the fish whose movements cause earthquakes, the *kappa*, or demon of the deep, and dragons of sufficient variety of form to satisfy the weirdest imagination.

NOTES

RARELY has so distinguished and representative an assembly been seen in Westminster Abbey as that which met to pay the last honours to Mr. Darwin, on Wednesday last week. The Abbey indeed was crowded. The character of the long line of distinguished men who followed the honoured remains to the grave, may be seen from the list of pall-bearers:—The Duke of Devonshire, the Duke of Argyll, the Earl of Derby, Mr. J. Russell Lowell, the American Minister, Dr. W. Spottiswoode, P.R.S., Sir Joseph Hooker, Mr. A. R. Wallace, Prof. Huxley, Sir John Lubbock, and the Rev. Canon Farrar. Mr. Darwin has been buried close beside the grave of Sir John Herschel, and within two paces of that of Sir Isaac Newton. At the Royal Academy dinner on Saturday, Mr. Spottiswoode, in replying for science, could not but refer to the loss "of our greatest philosopher and noblest spirit." "I know not," he said, "whether, in the presence of statesmen and leaders of thought, of commanders both by sea and land, of artists, of preachers, of poets and men of letters of every kind, it is fitting that I should speak of greatness; but if patience and perseverance in good work, if a firm determination to turn neither to the right hand nor to the left, either for glory or for gain, if a continual overcoming of evil with good in any way constitute elements of greatness, then the man of whom I speak—Charles Darwin—was truly great. He lived, indeed, to a good age; he lived to complete the great work of his life; he lived to witness a revolution in public opinion on matters with which he was concerned such as few had seen before—a revolution from opposition to concurrence, a revolution from antipathy to sympathy, or whatever else may better express a complete change of front. And so having at the beginning been somewhat rudely pushed aside as an intruder and disturber of accepted opinions, he was in the end not only borne on the shoulders of his comrades to his last resting-place, but was welcomed at the threshold by the custodians of an ancient fabric and of an ancient faith as a fitting companion of Newton and of Herschel, and of the other great men who from time to time have been gathered there."

M. JAMIN, president of the Academy of Sciences, having summoned M. Quatrefages to deliver an *éloge* on the late Mr. Charles Darwin on Monday last, the eminent zoologist read a long and eloquent oration, which was received with unanimous plaudits, and will be printed in the next *Comptes Rendus*.

WE take the following from the *Times*:—The Council of the Royal Society have selected the following fifteen from the fifty-two candidates for the Fellowship who have presented themselves during the present session. The election, which rests with the Fellows of the Society, will take place on Thursday, June 8, at 4 p.m. The names are—Prof. V. Ball, Dr. G. S. Brady, Dr. G. Buchanan, C. Baron Clarke, Francis Darwin, Prof. W. Dittmar, Dr. W. H. Gaskell, Mr. R. T. Glazebrook, Mr. F. Ducane Godman, Mr. J. Hutchinson, Prof. A. Liversidge, Prof. I. Malet, Mr. W. D. Niven, Mr. R. H. Inglis Palgrave, and Mr. W. Weldon.

THE fifty-second Annual Meeting of the British Association for the Advancement of Science will commence in Southampton on Wednesday, Aug. 23. The President-Elect is C. W. Siemens, D.C.L., F.R.S. Vice-Presidents-Elect: The Right Hon. the Lord Mount-Temple, Capt. Sir F. J. Evans, K.C.B., F.R.S., Hydrographer to the Admiralty, F. A. Abel, C.B., F.R.S., Prof. de Chaumont, M.D., F.R S., Col. A. C. Cooke, R.E., C.B., Director-General of the Ordnance Survey, Wyndham S. Portal, Prof. Prestwich, M.A., F.R.S., Philip Lutley Sclater, F.R.S. General Treasurer: Prof. A. W. Williamson, F.R.S., University College, London, W.C. General Secretaries: Capt. Douglas Galton, C.B., D.C.L., F.R.S., Francis Maitland Balfour, F.R.S. Secretary, Prof. T. G. Bonney, F.R.S. Local Secretaries: C. W. A. Jellicoe, John E. Le Feuvre, Morris Miles. Local Treasurer, J. Blount Thomas. The Sections are the following: A—Mathematical and Physical Science—President, Right Hon. Prof. Lord Rayleigh, F.R.S. Vice-Presidents: G. H. Darwin, F.R.S., Prof. G. C. Foster, F.R.S. Secretaries: W. M. Hicks, M.A., Prof. O. J. Lodge, D.Sc., D. McAlister, M.A., B.Sc. (Recorder), Rev. G. Richardson. B—Chemical Science—President, Prof. G. D. Liveing, F.R.S. Vice-Presidents: A. G. Vernon Harcourt, F.R.S., Prof. H. E. Roscoe, F.R.S. Secretaries: P. Phillips Bedson, D.Sc. (Recorder) H. B. Dixon, F.C.S., J. L. Notter. C—Geology—President, R. Etheridge, F.R.S. Vice-Presidents: Prof. T. Rupert Jones, F.R.S., Prof. J. Prestwich, F.R.S. Secretaries: T. W. Shore, F.G.S., W. Topley, F.G.S. (Recorder), E. Westlake, F.G.S., W. Whitaker, F.G.S. D—Biology—President, Prof. A. Gamgee, M.D., F.R.S. Vice-Presidents: Prof. W. Boyd Dawkins, F.R.S., G. E. Dobson, F.L.S., Prof. M. A. Lawson, F.L.S., Prof. J. D. Macdonald, F.R.S. Department of Anatomy and Physiology:—Prof. A. Gamgee, M.D., F.R.S. (President), will preside. Secretaries: W. Heape, A. Sedgwick, B.A. (Recorder). Department of Zoology and Botany:—Prof. M. A. Lawson, F.L.S. (Vice-President), will preside. Secretaries: W. A. Forbes, F.Z.S. (Recorder), J. B. Nias. Department of Anthropology :—Prof. W. Boyd Dawkins, M.A., F.R.S., F.S.A., F.G.S. (Vice-President), will preside. Secretaries: G. W. Bloxam, M.A., F.L.S.) (Recorder), T. W. Shore, jun., B.Sc. E—Geography :—President: Sir R. Temple, Bart, G.C.S.I. Vice-Presidents: H. W. Bates, F.R.S., Lieut.-Col. H. H. Godwin-Austen, F.R.S. Secretaries: E. G. Ravenstein, F.R.G.S., E. C. Rye, F.Z.S. (Recorder). B—Economic Science and Statistics :—President: Right Hon. G. Sclater-Booth, M.P., F.R.S. Vice-Presidents: W. E. Darwin, F.G.S., R. H. Inglis Palgrave, F.S.S. Secretaries: G. S. Baden-Powell, F.S.S., Prof. H. S. Foxwell, F.S.S., A. Milnes, M.A., F.S.S., Constantine Molloy (Recorder). G—Mechanical Science :—President: John Fowler, C.E., F.G.S. Vice-Presidents: A. Giles, C.E., W. H. Preece, C.E., F.R.S. Secretaries: A. T. Atchison, M.A., F. Churton, H. T. Wood, B.A. (Recorder). The First General Meeting will be held on Wednesday, August 23, at 8 p.m. precisely, when Sir John Lubbock, Bart., M.P., F.R.S., will resign the Chair, and C. W. Siemens, D.C.L., F.R.S., President elect, will assume the Presidency, and deliver an address. On Thursday evening, August 24, at 8 p.m., a *soirée;* on Friday evening, August 25, at 8.30 p.m., a Discourse on Pelagic Life, by Prof. H. N. Moseley, F.R.S.; on Tuesday evening, August 29, at 8 p.m., a *soirée;* on Wednesday, August 30, the concluding General Meeting will be held at 2.30 p.m.

It may be useful for some of our readers to be informed that the following arrangements have been made by the American Association for the Advancement of Science for reduced fares from Europe to Montreal, for those attending the meeting on August 23 next :—The Allan Line will grant ten tickets at $100 each from Liverpool to Quebec and return; the Dominion Line will grant twenty-five tickets at $80 each from Liverpool to Quebec and return; the Beaver Line will grant tickets from Liverpool to Quebec and return at $80 each.

THE eleventh meeting of the French Association for the Advancement of Science will take place at Rochelle, commencing August 24. The General Secretary is Prof. Gariel, 4, rue Antoine Dubois, Paris.

THE honorary degree of LL.D. has been conferred on Mr. J. R. Hind, F.R.S., by the University of Glasgow.

THE death is announced, at the age of forty-eight, of the well-known physicist Prof. Zöllner, of Leipsic.

LADY THOMSON, widow of Sir Wyville Thomson, is to receive a grant of 400*l.* from the Royal Bounty Fund.

THE French Eclipse Expedition has arrived at Alexandria.

ON April 27 the French Academy received M. Pasteur, who has been nominated to fill the chair vacated by the recent death of M. Littré. The ceremony attracted an immense concourse of people, including the *élite* among French *savans* and politicians. M. Pasteur delivered an eloquent address against the opinions of his predecessor, who was partly defended by M. Renan. The two speeches are among the most interesting and elaborate that have been delivered under such circumstances.

WE have received, as specimens of the seismological literature of Japan, reprints of certain translations which have appeared in the *Japan Gazette* newspaper. The first is the narrative of an earthquake shock at Osaka, accompanied by a high wave, in 1707; the second, a similar narrative of a great earthquake in the province of Echigo in 1829; and the third an earthquake chronology. The editor, Prof. Milne, speaks of the first as little more than a series of anecdotes of various events which took place at the time of the disaster; and although the seismologist may not be able to glean many facts of value, the paper will at least give him a specimen of the kind of literature through which he will have to wade in searching for facts of scientific importance. He adds that he is acquainted with sixty-five Japanese works on the subject, and that in Japan there is a literature on earthquakes comparable with that of any other country, and although much of it may be of interest only to the general reader, much of it has a value scientifically. The second monograph is interesting, on account of the many references it contains to popular beliefs respecting the connection between earthquakes and other natural phenomena. Thus, an unusual warmness in the weather, a change in the colour of the moon, mirage, falling stars, &c., are all referred to as being connected with the approach of an earthquake. The third paper is a translation of an earthquake Calendar, commencing at 295 B.C. and ending with the widespread and destructive earthquakes of 1854. This work shows that, notwithstanding the frequency of these phenomena in Japan, the native chroniclers have always carefully recorded them. Probably nowhere else in the literature of the world can we find so long and complete a record of the recurrence of various natural phenomena—for eclipses, great waves, volcanic eruptions, &c., are also noted—than in this work.

A SERIES of three excursions has been arranged by the Geologists' Association, to afford members an opportunity of becoming acquainted with the physiography and geological character of the Weald. The first excursion, on May 6, will be to Redhill and Crawley; the second, May 30, to Tilgate Forest, Cuckfield, and Hayward's Heath; and the third, May 29 and 30, to the Isle of Purbeck.

THE annual general meeting of the Iron and Steel Institute will take place on May 10, 11, and 12. The papers to be read are :—On certain physical properties of iron and steel, by Mr. Edward Richards, Hematite Steel Works, Barrow-in-Furness; On the use of brown coal in the blast furnace, by Prof. Ritter Peter von Tunner, Leoben, Austria; On the Bilbao iron ore district, by Mr. William Gill, M.I.C.E., Luchana, Bilbao, Spain; On a new method of getting coal, by Mr. Paget Mosley, London; On the compression of fluid steel, by Mr. William Annable, Govan, Glasgow; On the chemical composition and testing of steel rails, by Mr. G. J. Snelus, F.C.S., A.R.S.M., Workington; On the consumption and economy of fuel in iron and steel manufacture, by Mr. J. S. Jeans, London; On the tin plate manufacture, by Mr. Ernest Trubshaw and Mr. E. S. Morris; On the relations of carbon and iron, by Mr. Geo. E. Woodcock, Atlas Works, Sheffield; On a new centre crane for Bessemer plant, by Mr. Thomas Wrightson, M.I.C.E., Stockton-on-Tees.

ON April 30 M. Carlier, one of the most active members of the Académie d'Aérostation Météorologique, made an ascent at the La Villette gasworks, Paris, in order to try if it is possible to steer a balloon by using in the car a large oar composed of a plane fixed perpendicularly to a solid handle worked with two hands. The dimensions of the plane are one metre by two, and the handle is about three metres long. The weight of the sails is counterpoised when worked, and the weight of the whole system is about 10 kilograms. It is the second time that M. Carleer has ascended with this apparatus. Although the air was in a state of great agitation the motions of the balloon were easily seen from the ground. M. Carlier intends to make a series of ascents in order to learn how to make the best of this system, which is to be used only for partial direction, as in the case of Thames barges, which, although they must follow the run of the tides, can be directed to some extent by means of the oars.

THE May number of the *Proceedings* of the Royal Geographical Society contains a paper of much interest by Mr. L. K. Rankin, B.A., on "The Elephant Experiment in Africa." Mr. Rankin accompanied Capt. Carter on his journey with the three Indian elephants in 1879, meant for the use of one of the Belgian expeditions. In his paper Mr. Rankin gives full details of the conduct of the elephants up to Mpwapwa, where their troubles began. Although they were severely attacked by the Tsetse, no permanent evil effect seems to have followed. At Mpwapwa, indeed, a report was sent to the King of the Belgians, in which it was stated that the elephant experiment was a complete success, on account of their immunity against Tsetse, their ability to live on the uncultivated food of the country, and to march over all kinds of ground. A few days after the report, however, the largest elephant suddenly died. Mr. Rankin attributed its death to insufficient food and over-work. In India it had been stall-fed ; in Africa it never seems to have had enough to eat—the back-bones of all these stood six or seven inches from their flanks at Mpwapu. It is clear also that their loads were far beyond what they had been accustomed to. As is known, the other elephants subsequently died. This experiment cannot be considered a fair one, though the lessons it taught will be of service in any future attempt to utilise the animal as a beast of burden in Africa.

A HYDROMOTOR recently invented by Herr Fleischer of Kiel, for propulsion and steering of vessels, acts (we learn from Wiedemann's *Beiblätter*, 3) by pressure of steam on water, in a cylinder, forcing out the water as a jet below. A float on the water in the cylinder works, in a simple way, the opening and closure of the valves for admission and escape of the steam, and the vacuum produced by condensation of steam in a condenser opens valves for readmission of water. The hot water layer, which forms on the liquid surface, and the wooden lining of the cylinder, reduce the condensation during expulsion of the water to a minimum. A comparison of the working of the author's vessel with that of the *Water-witch* and *Rival* (also propelled by hydraulic reaction) showed that while the kinetic energy of the expelled water was in the *Water-witch* 31·5 per cent. of the indicated quantity of steam, and in the *Rival* 26·3 per cent. in the (so-called) "hydromotor" it was 89 per cent. Herr Flischer, in a recent *brochure*, investigates the physics of his motor.

IF those members of the Quekett Microscopical Club who intend to be present on the occasion of the opening of Epping Forest by Her Majesty on Saturday next, the 6th inst., will communicate with the Hon. Sec. of the Quekett Microscopical Club, 7, The Hill, Putney, S.W., he will do his best to find places for their accommodation.

WITH reference to our notice of "Through Siberia" (vol. xxv. p. 582), the Rev. H. Lansdell writes that in the List of Illustrations at the commencement of vol. i. he acknowledges the sources whence they are taken ; and with reference to the photograph of a "Buriat girl" he states that he bought the photograph, in the Buriat country, of the man who took it, that the girl was known even by name to his local friends, and that he has every reason to believe she was a pure Buriat and not a metis.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus* ♂) from India, presented by Mrs. Lamprey ; a Chinese Tiger (*Felis tigris* ♂) from China, presented by Mr. G. Brown ; two Bauer's Parrakeets (*Platycercus zonarius*) from Australia, presented respectively by Mr. J. Charlton Parr, F.Z.S., and Miss Eva Maitland ; a Mississippi Alligator (*Alligator mississippiensis*) from Florida, U.S.A., presented by Master Bennett ; a Slow-worm (*Anguis fragilis*), British, presented by Mr. Poyer Poyer ; two Axolotls (*Siredon mexicanus*) from Mexico, three European Pond Tortoises (*Emys europæa*), five Carpathian Scorpions (*Scorpio carpathicus*) from Italy, presented by Mr. T. D. G. Carmichael ; a Black-backed Piping Crow (*Gymnorhina tibicen*) from Australia, deposited ; two Common Squirrels (*Sciurus vulgaris*), British, two Green-horned Parrakeets (*Nymphicus uvæensis*) from the Island of Uvea, Loyalty group, purchased ; a Black-backed Kaleege (*Euplocamus melanotis*) from Sikkim, received in exchange ; a Hybrid Paradoxure (between *Paradoxurus larvatus* and *Paradoxurus leucomystax*), two Variegated Sheldrakes (*Tadorna variegata*), bred in the Gardens. The following insects have been exhibited in the Insect House during the past month :—Butterflies : *Papilio podalirius*, *Anthocharis cardamines*, *Araschnia levana*, *Thais polyxena*. Moths : *Deilephila euphorbiæ*, *Chærocampa elpenor*, *Sphinx pinastri*, *Saturnia pyri*, *S. carpini*. Silk Moths : *Attacus roylei*, *Actias selene*, *A. luna*, *Telea polyphemus*. The insects have, with few exceptions, been very good specimens.

OUR ASTRONOMICAL COLUMN

THE PRESENT COMET.—The following orbit of the comet discovered by Mr. Wells on March 17 has been calculated by Mr. Hind from the Harvard College and Albany observations on March 17, and observations by Prof. Tacchini at the Collegio Romano in Rome on April 6 and 21 ; the small corrections were taken into account :—

Perihelion passage, June 10·69852 M.T. at Greenwich.

	°	′	″	
Longitude of perihelion	53	47	46·3	From mean equinox 1882·0.
,, ascending node ...	205	8	2·6	
Inclination	73	57	47·2	
Logarithm of perihelion distance	8·796420			

Motion—direct.

Hence the positions for Greenwich midnight will be—

	R.A.			Decl.		Log. distance from	
	h.	m.	s.	°	′	Earth.	Sun.
May 4	21	19	11	+71	31·3	9·9870	0·0670
5	21	36	12	72	19·0		
6	21	54	57	73	1·5	9·9793	0·0502
7	22	15	27	73	37·7		
8	22	37	35	74	6·4	9·9724	0·0324
9	23	1	9	74	26·4		
10	23	25	49	74	36·9	9·9664	0·0134
11	23	51	6	74	37·1		
12	0	16	22	+74	26·4	9·9612	9·9932

If the intensity of light on March 19 be taken as unity, the intensity on May 12 is 15·6.

The perihelion distance is given by different computers as follows :—

Kreutz—observations to April		7	0·06343
Lamp	,,	,, 9	0·06123
Oppenheim	,,	,, 11	0·06459
Hind	,,	,, 21	0·06258

From the above elements it will be found that at the ascending node the comet makes a close approach to the earth's orbit, the distance being only 0·0048, or, assuming 8″·848 for the solar parallax, 443,500 miles, roughly twice the distance of the moon. The ascending node is passed on July 11, but the earth will be far from that point of her orbit.

THE SO-CALLED *Nova* of 1848.—There does not appear to be any recent notice of the magnitude of this object, though the last published observations by Dr. Julius Schmidt in 1868 showed that it had not sensibly changed for some years. It was slightly over 13m. Its position for 1880·0 is in R.A. 16h. 52m. 46·5s., N.P.D. 102° 42′ 26″. Webb in the last edition of his "Celestial Objects for Common Telescopes," p. 356, says : "colour very fine, 1875," but this note must surely refer to some other object, the *Nova Ophiuchi* of 1848, having been too faint for years past to show striking colour. Perhaps some reader of NATURE may be able to state what is its present degree of brightness. There are two stars having the following positions with reference to *Nova* which may assist its identification.

11m.	Angle	249°·4	Distance	7′ 55″
10·11m.	,,	144°·5	,,	8′ 51″

It follows a 9m. Lalande-star 14·7s., and is 18′ 22″ north of it. In 1874 it was below the twelfth magnitude.

GEOGRAPHICAL NOTES

LIEUT. DANENHAUER and two of the crew of the ill-fated *Jeannette* have arrived at St. Petersburg, where they were met with a hearty reception. Lieut. Danenhauer has little hope that Capt. De Long and those with him can have survived, though Engineer Melville is searching for them. He speaks of the unsatisfactory nature of the charts of the Lena mouths and that part of the Siberian coast, and states that Baron Nordenskjöld has added little to our knowledge in this respect. But the Baron did not profess to do so, and indeed could not, seeing that his aim was to get over the ground as quickly as possible. The Lieutenant also is not sanguine as to the possibility of opening up trade by the mouth of the Siberian rivers, forgetting apparently that the time of his arrival at the Lena mouth was past the time most favourable for navigation, and the conditions of his arrival were certainly unfortunate.

WRITING on Chinese maps, the *North China Herald* says that the present dynasty has made greater efforts at map-making than any former one, and appears to have been the first to introduce into them lines of latitude and longitude. The old maps of China are very vague and inaccurate, and are not ancient in any sense. Ssu-ma-Chien when compiling his history did not judge it needful to illustrate it with maps, but his commentators have supplied this deficiency, and recent editions of his work contain maps poorly done of China at successive periods. The geographical works of the Han dynasty do not contain maps. The first maps that have been retained in modern editions of ancient books are those of the Sung dynasty, and they seem to be connected with the invention of printing, which dates from A.D. 932. It was the influence of foreign countries that caused the Chinese to enter rigorously into the work of map-making at this period. The Buddhists began to compile works with maps of India and the countries through which lay the routes to India. One of their larger works at this time contains a map of China, of Persia and Rome, according to the geography of the Han dynasty, and a map of India as known to the Buddhists. The Mahommedans followed the latter in teaching their notions of map-making to the Chinese. But all through the Sung dynasty till the 13th century, when the Mongols established their Empire, Chinese scholars possessed but imperfect views of geography, and failed to obtain clear ideas either of foreign countries or of their own in regard to topography. During the Mongol domination many Europeans visited China and brought with them a certain portion of geographical knowledge. No steps, however, were taken by the Government to improve maps and common geographical books, which remained as bad as before. The Chinese had junks in the Indian Ocean from the 5th century, yet in the 16th century we find in maps of that time that Cambodia and Siam are islands; that Java lies west of Siam, that the Greek empire (Fulin), Arabia, and Medina are three small islands a little to the west of Java, and that an immense southern continent fringes the map from a little south of Ceylon to a point not far south of Java, and again farther east. Good maps have only existed since the Jesuit missionaries came to China, and they belong only to the present dynasty. The Emperors Khang-hi and Kien-lung encouraged the survey of their dominions and the construction of good maps. Danville's *Atlas Chinois* is the result in French of the surveys made under Khang-hi by Gerbillon and his companions. All European maps of China rest mainly on those surveys. Among the atlases of the empire, that made by a former governor of Honan province deserves special praise. It is on a large scale. Each square of 200 *li* represents a square degree. Two inches and a half represent 200 *li*. This affords ample space for names, which are freely inserted on the most frequented roads. As a specimen of engraving it is rough, and of course being on wood and done by provincial workmen it cannot equal the copperplate maps which were issued last century from the Government workshops in Peking. But it is in comparison with past times a great advantage to the people to have a map on a large scale for four or five dollars, on which both degrees and miles are marked by a system of chess-board squares with quite sufficient accuracy for ordinary use. For this they are indebted to Khang-hi and the Jesuits.

MR. C. R. MARKHAM has presented to the Geographical Society a long and careful report on the instruction at present supplied to this country in practical astronomy, navigation, route-surveying, and mapping. Although much improvement has taken place since nautical astronomy was placed in the South Kensington programme, still Mr. Markham shows that much remains to be done ere practical instruction in these important subjects is on the footing on which it ought to be in a country whose interests are so dependent on good seamanship. The Council, on the basis of Mr. Markham's report, have made a series of recommendations to the Board of Trade and the Lord-President of the Council; the former are recommended to raise their standard, and the latter to place navigation and nautical astronomy among the science subjects in the New Code. The report and the recommendations deserve serious consideration.

THE last two parts of the *Deutsche geographische Blatter* contains detailed accounts, by the Brothers Krause, of their researches in the Chukchi Peninsula, accompanied by maps and illustrations; this forms a valuable addition to the information obtained by the *Vega* Expedition. Nos. 2 and 3 of the *Mittheilungen* of the Vienna Geographical Society contains a paper by Herr Ferd. Blumentrit, on the Ancestor-Worship and Religious beliefs of the Malays of the Philippine Islands.

M. MASCART is delivering daily lectures to the naval officers who are to leave on June 1, on the Antarctic Expedition now fitting out at the expense of the French Government. These lectures are delivered at the Parc St. Maur, where instruments have been established. The lecture will be published by Gauthier Villars, after having been revised.

IN the April number of *Petermann's Mittheilungen* M. Ernest Marno gives an interesting account of the barriers of the Bahr-el-Gazal, and their removal from April to June, 1881. Dr. Fera Loïol of Prag contributes a long paper of great interest, with numerous illustrations, on the formation of terraces in the Alpine valleys. Dr. Oscar Drude writes on the botanical exploration of North Africa from Morocco to Barca.

"A VISIT to Madeira in the Winter 1880 81" is the title of two lectures by Dr. Denis Embleton, of Newcastle-on-Tyne, published by Messrs. Churchill. Dr. Embleton, besides giving his own experience, has brought together much information on the islands in all their aspects.

THE Dutch Polar Expedition, which participates in the great International undertaking, will start for Port Dickson on July 1 next. Half the cost is borne by the Dutch Government, the other half having been raised by public subscription. The expedition will return in 1884 if all is well. At the same time the annual Dutch Polar Expedition to the Novaya Zemlya region—the fifth—will start early in May from Amsterdam, commanded by Lieut. Hoffmann. They hope to return in October.

SOME OF THE DANGEROUS PROPERTIES OF DUSTS[1]

THE lecturer pointed out that the dangerous properties of dust with which he proposed to deal were altogether distinct from the subtle, invidious dangers of microscopic dust-motes which pervade the air—dangers the existence and nature of which had been fully revealed by the classical researches of Pasteur, Tyndall, &c.

Compared to those, the dangers which he would discuss were as palpable as are the comparatively gross dust-particles which give rise to them, and yet, although their existence and, to a great extent at any rate, their causes have been known and demonstrated for many years, those who are most directly interested in them and should be most keenly alive to them appear either to have ignored their serious import or to have undervalued the teachings of practical experience and scientific research regarding their causes and effects.

Seven years ago Mr. Abel, in a lecture on Accidental Explosions, delivered at the Royal Institution, directed attention to the fact that solid combustible and especially inflammable substances, if sufficiently light and finely divided to allow of their remaining for a time thickly suspended in air, may on application of sufficient flame to them while so suspended, produce explosive effects; behaving, in fact, similarly to mixtures of inflammable gases or vapours with air, with this difference, that the mobility of the molecules of these insures the ready production of complete mixtures of them with the air, so that combustion, when once established, proceeds almost instantaneously throughout such mixtures, whereas, in the case of a mixture of solid dust particles and air, the rapidity with which combustion spreads

---

[1] Abstract of Lecture at the Royal Institution, April 28, 1882, by Prof F. A. Abel, C.B., F R.S.

through it depends upon the state of division of the solid, and the abundance of its distribution through the air. Under the most favourable circumstances, the rapid combustion or explosion of such a mixture is of a comparatively moderate kind, as it has to spread from one isolated particle to another. With highly inflammable solids, the rapidity of combustion under such conditions is greatest, because, as each particle burns it also evolves inflammable vapour, and is enveloped in flame which produces corresponding effects upon the immediately adjacent particles. In order to ensure rapid and complete transmission of flame through a mixture of inflammable dust and air, it is essential that the former should be present in great abundance, for the foregoing reasons, and that it should therefore be considerably in excess over the supply of oxygen in the air. The facility with which, under these conditions, flame may be transmitted by a dust-and-air-mixture, with a rapidity calculated to produce more or less violently destructive effects, according to the scale upon which the combustion occurs and the degree of confinement of the burning mixture, has been abundantly demonstrated by accidents, many of them very disastrous, which have occurred in works where large quantities of inflammable dust are unavoidably produced. Thus, in the grinding of sulphur, the inflammation of dust of that substance, consequent upon the over-heating of a shaft-bearing, has produced an explosion sufficiently violent to destroy the chambers within which the operation was conducted. In cotton mills, the accidental ignition of finely divided cotton fibre floating in the air has led to the very rapid spread of conflagrations throughout extensive buildings. Even in a factory where the spent madder, or guaracine, is ground, whereby a much less inflammable dust than that of cotton is produced, an important explosion occurred a few years ago. But the most numerous and extensive calamities of this kind have taken place, and are still of frequent occurrence, in flour and rice mills. Many such explosions, or very rapidly spreading conflagrations, occurring in different parts of the continent and here, prior to 1872, appeared enveloped in mystery, until their probable cause was indicated by an Austrian observer, and soon afterwards made clear by Dr. Watson Smith, and especially by the careful inquiry which Messrs. Rankin and Macadam instituted into the very serious and fatal explosion which occurred at the Tradeston Flour Mills, in Glasgow, in 1872. The origin of this explosion was conclusively traced to the striking of fire by a pair of millstones, through a stoppage in the feed of grain, the results being the ignition of the mixture of flour-dust and air by which the mills, inclosed in a chamber, were surrounded, and the rapid spread of flame to the mixture of dust and air which filled the conduits leading to the exhaust box, which communicated with the several other mills and with the stive-room. In this way flame was so quickly transmitted through and to various channels and confined spaces in different parts of the building as to produce violently explosive effects almost simultaneously in different parts of the buildings. Messrs. Rankin and Macadam ascertained that accidents of this nature had increased in frequency since exhaust arrangements (for collection of the fine flour) had been adopted in the more extensive mills. The precautionary measures suggested by them were, the adoption of efficient precautions for preventing the stoppage of the feed to the millstones, the exclusion of naked flames from the vicinity of these and the dust passages, and the construction of the exhaust boxes and stive-rooms as lightly as possible, and their location outside the main buildings.

The liability to the development of fire or of heat sufficient to char or inflame portions of flour by the stoppage of the feed of grain, appears from all accounts to be extremely difficult to guard against, and to have been the cause of many serious calamities even since the Tradeston explosion, examples of which are the great explosion of six mills at Minnesota in 1878, when eighteen lives were lost and much property was destroyed; and the fatel and destructive explosion of a flour mill at Macclesfield in September last, which has been made the subject of a Report to the Home Office by Mr. Richards, of the Board of Trade. It appears to be the opinion of experienced men in the trade that, although special attention to the feed arrangements may reduce the number of explosions, this cause of accident is almost impossible to guard against; while on the other hand, many fires or explosions, ascribed to it, have been due to the employment of naked lights in mills near localities where the air is laden with flour-dust. Considering that flour- and rice-mill-owners have to bear the the burden of very heavy rates of insurance, it is to their interest, independently of their responsibilities as the guardians of the lives of their workmen, to adopt most stringent regulations and efficient precautionary measures for abolishing this source of danger, and to devote their energies to the application of improved arrangements for reducing the quantity of dust which passes away from the millstones and from other parts of a flour mill.

The important part played by coal-dust, which exists in greater or less abundance in coal-mines, in aggravating and extending the injurious effects of fire damp explosions, was originally pointed out early in 1845 by Faraday and Lyell, when they reported to the Home Secretary the results of their inquiry into an explosion which occurred at Haswell Collieries in September, 1844. That Report, which was published in the *Philosophical Magazine* for January, 1845, dealt exhaustively with the cause of the explosion, and the means by which a recurrence of such a calamity might be guarded against, and the latter subject was again discussed by Faraday in a lecture delivered at the Royal Institution in February, 1845, and in a letter published directly afterwards in the *Philosophical Magazine*. It is pointed out in Faraday and Lyell's Report, that in considering the extent of the fire from the moment of the explosion, fire-damp must not be supposed to be the only fuel, for that the coal-dust swept up by the rush of wind and flame from the floor, roof, and walls of the working would instantly take fire, and, in support of this statement, they refer to considerable deposits of dust in a partially coked condition which they found adhering to the faces of pillars, props, and walls where the explosion had occurred and the fire had extended. An examination of these deposits showed that the coal was deprived more or less completely of its bituminous constituents, and they concluded from this that the exposure of the dust to the flame of the exploding gas-mixture gave rise to the generation of much coal-gas from it, the carbon, or coke, remaining unburnt only for want of air.

Ten years after the publication of Faraday and Lyell's Report, M. de Souich, an eminent French mining engineer, published, as original, some very similar observations made by him on examining the effects of a coal-mine explosion at Firminy; he noticed, moreover, that men near the pit's mouth had received burns, while others who were in the workings near the seat of the explosion, but out of the main air current, escaped unhurt, and he ascribed this to the action of coal-dust in carrying flame along the principal air-way. Later on, De Souich extended his inquiries into the part played by coal-dust in explosions, and the subject was afterwards pursued from time to time in France by Verpilleux and other authorities in mining engineering, and especially by M. Vital in 1875, when an explosion occurred at Campagnac, the destructive effects of which appeared to him in a great measure ascribable to coal-dust. Vital made experiments upon a very small scale for the purpose of ascertaining whether flame, such as that projected into the air of a mine by the firing of a charge of powder, in a very strong blast-hole, was increased in size by the presence of suspended coal-dust; and soon afterwards Mr. W. Galloway commenced a series of experiments of a similar nature, but upon a larger scale, which he has continued from time to time up to the present date; while Messrs. Marreco and Morison, in connection with the North of England Institute of Mining Engineers, and a committee of the Chesterfield and Derby Institute of Engineers, have also contributed valuable experimental data bearing upon the influence exerted by coal-dust, not merely in increasing the magnitude of explosions resulting from the ignition of mixtures of fire damp and air, but also in propagating or even actually developing explosions, when only small quantities of fire-damp are present in the air of a mine, or where fire-damp is believed to be entirely absent. The conclusion to which Mr. Galloway was led by his earlier experiments was to the effect that coal-dust, when thickly suspended in air, had not the power to originate an explosion, or to carry on to any distance the flame from a blown-out shot, but that the presence in the air of such small quantities of fire-damp (2 per cent. and under) as an experienced miner would fail to detect by means of his Davy lamp, with which the gas is generally searched for, would impart to a mixture of coal-dust and air the property of burning and carrying flame. But he held the view at the same time, that a fire-damp explosion in one part of a mine might be propagated to some extent by coal-dust raised by the effects of the explosion in parts of the mine where no fire-damp existed. Marreco, on the other hand, considered that the results of certain experiments made in the entire absence of coal-dust, by firing shots in air travelling at some considerable velocity, and containing coal-dust thickly suspended in it, warranted the conclusion that coal-dust also might, under certain conditions, originate an explosion as well as carry it on to some considerable extent. The results obtained by the corresponding experiments of the Chesterfield Committee appear to support this view, and Mr. Galloway has also, by his later experimental results, been led to the same conclusion, and considers that the results of his examination into the effects produced by some of the most serious of recent coal-mine explosions (at Penygraig, Risca, and Seaham) demonstrate that those explosions were chiefly, if not entirely attributable to coal-dust.

Notwithstanding the considerable light that was thrown on this subject so far back as 1845 by Faraday and Lyell, and the accumulation of experimental and other observations relating to the action and effect of coal-dust in colliery explosions, these have not until quite recently received the attention which they merit at the hands of mine owners, and many of those in authority connected with coal-mines. Evidence collected by the Royal Commission on Accidents in Mines, from mine inspectors and leading mining engineers (and published with the preliminary Report of the Commission), show the preponderance of opinion to be against the view that explosions could originate, or be to any great extent propagated, by coal-dust, in the absence of fire-damp, though the belief is entertained by many that the coal-dust may be credited with an extension or aggravation of explosions caused by fire-damp. On the other hand, there is a great tendency exhibited always to ascribe explosions which do not admit of satisfactory explanation, by an accidental failure of ventilation or other evident causes, to a sudden disengagement, or outburst, of fire-damp, such as is of no uncommon occurrence in fiery mines, and is sometimes very serious in its magnitude and duration. That such outbursts, following upon falls of roof and the firing of blast holes, have been the cause of many disastrous explosions, there can be no doubt, but, in some instances, the conclusion that an explosion had been due to this cause, is based upon assumptions and upon very doubtful evidence. Under any circumstances, it is extremely difficult to realise how sufficient gas to produce an explosive atmosphere, can be conveyed, even by the most powerful currents, from the seat of such a sudden outburst to far distant portions of the mine, to which the burning effects of an explosion have been found to extend, within the period believed to have elapsed between the first outburst of gas and the ignition of an explosive atmosphere formed in its vicinity. On the other hand, the evidence of severe burning, after an explosion, such as could not be produced by the rapid explosion of a gas-mixture alone, and the deposition of partially burned coal-dust in distinct parts of a mine, distant from each other and from the point to which the origin of the explosion has been traced, seem to leave no doubt that coal-dust has played an important part in many of the explosions which have of late been subjected to rigorous investigation.

The strong impression entertained by many, during the inquiry into the great explosion at Seaham Collieries, in September, 1880, that coal-dust might have had much to do with the accident, and that the explosion was possibly even entirely due to the ignition of coal-dust by a blown-out shot, in the absence of any fire-damp, led to Mr. Abel's being requested by the Home Secretary to make experiments with samples of dust collected in the mine, and to an extension of these experiments to dust collected from collieries in different parts of the kingdom where explosions had occurred.

The results of experiments conducted with great care and on an extensive scale at a colliery in Lancashire, where a constant supply of fire-damp was brought to the pit's mouth from a so-called blower, confirmed the fact demonstrated by M. Vital and Mr. Galloway, that the propagation of fire by coal-dust, when thickly suspended in air, is established or greatly promoted by the existence, in the air, of a proportion of fire-damp, which may be so small as to escape detection by the means ordinarily employed (such for example as exists in the return-air of a well ventilated mine).

It was also established that a mixture of fire-damp and air approaching in proportion those required to be explosive, would be ignited by a flame if only a small proportion of dust were floating in it. Further, it was demonstrated that, although those dusts which were richest in inflammable matter, and most finely divided, were the most prone to inflame and to carry on flame, in the presence of small quantities of fire-damp, some dusts which contain coal only in comparatively small proportions were as sensitive as others much richer in inflammable matter, and that even certain perfectly non-combustible dusts possessed the property of establishing the ignition of air- and gas-mixtures which, in the absence of dust, were not ignited by a naked flame. This action of non-combustible dusts appeared to be due to physical peculiarities of the finely-divided matter, and to be perhaps analogous to the contact-action well known to be possessed by platinum and some other bodies, whereby these bring about the rapid oxidation of gases which, in their absence, may exist intact in admixture with oxygen or air.

Many experiments were tried with sensitive coal-dust from Seaham and other collieries, for the purpose of ascertaining whether results could be obtained supporting the view that coal-dust, in the complete absence of fire-damp, is susceptible of originating explosions and of carrying them on indefinitely, as suggested by some observers, but, although decided evidence was obtained that coal-dust, when thickly suspended in air, will be inflamed in the immediate vicinity of a large body of flame projected into it, and will sometimes carry on the flame to some small extent, no experimental results furnished by these experiments warranted the conclusion that a coal-mine explosion could be *originated* and carried on to any considerable distance in the *complete absence* of fire-damp. Some experiments made in a large military gallery at Chatham showed that the flame of a blown-out shot of 1½ lb. or 2 lb. of powder might extend to a maximum distance of 20 feet, while in a very narrow gallery, similar to a drift-way in a mine, the flame from corresponding charges extended to a maximum distance of 35 feet. These distances are considerably inferior to those which flame from blown-out shots has been known to extend, with destructive results, in coal-mines, and there appears no doubt that, in the latter cases, of which the lecturer gave examples, the flame was enlarged and prolonged by the dust raised by the concussion of the explosion. But, in these examples (with charges of 1 lb. of powder), the flame did not extend much beyond a distance of 100 feet, and therefore the power of the dust to carry an explosion or flame in these cases was limited. It was found, in experiments with the large Chatham gallery, in which the flame from a blown-out shot reached, in the absence of dust, to a maximum distance of 20 feet, that, when the atmosphere was thickly laden with a highly inflammable coal-dust, from Seaham Collieries, the flame was carried on to nearly double, and in one case a little more than double, the distance.

Although it may be very doubtful whether coal-dust, in the *complete absence* of fire-damp, can be credited with the production of extensive explosions, as has been recently maintained by some, there can be no question that, in the presence of only very small quantities of fire-damp, it may establish and propagate violent explosions; and that, in the case of a fire-damp explosion, the dust not only, in most instances, greatly aggravates the burning action and increases the amount of after-damp, but that it may also, by being raised and swept along by the blast of an explosion, carry the fire into workings where no fire-damp exists, and thus add considerably to the magnitude of the disaster. The supposition that extensive coal-mine explosions may be produced by coal-dust alone, in the complete absence of gas, necessitates the fulfilment of conditions which cannot but be at any rate very exceptional, but its acceptance is unnecessary to add to the formidable character of coal-dust as a source of danger and an agent of destruction in mines. The possibility of dealing with the dangerous dust in mines should therefore be as much an object of earnest work as has been the improvement of ventilating arrangements in mines.

The actual removal of dust-accumulations being in most instances impracticable, the laying of the dust by an efficient system of watering the mine ways, is a matter deserving serious attention. Although in some instances such a measure is not readily applicable, without injury to the workings, it has been already proved in some districts to be unobjectionable and susceptible of very beneficial application. The employment of deliquescent substances (calcium chloride, sea-salt, &c.), in conjunction with watering, has also been advocated and tried to some extent with success.

The elaboration of really safe and sufficient methods of getting coal where blasting by powder is now resorted to, and of removing the harder rock in the working of drifts, &c., where fire-damp may exist, must most importantly contribute towards the diminution of danger arising from the accumulation of dust in mines, both by avoiding the projection of flame into the air, and by avoiding powerful concussions, whereby dust is raised; and the lecturer referred in conclusion to the various plans, in addition to coal-cutting machines, which had been devised to dispense with powder, or render its employment safe. The use of compressed air had been attended by some measure of success, and the dispersion of water, used as tamping, by the explosion of a powder charge in the form of a spray, had been shown to have frequently, though not reliably, the effect of drowning the flame developed by the explosion. The employment of water-columns, by which the force developed by the detonation of dynamite was uniformly transmitted throughout the entire length of the hole, had been proved, by experiments in coal-mines in Lancashire, and special test-experiments at Cardiff, to render that material very suitable for coal-getting, and at the same time to render blasting possible without liberation of flame. Lastly, the employment of cylinders or cartridges of compressed quicklime, according to a simple system elaborated by Professors Smith and Moore, was referred to as ranking before all other methods of getting coal, yet proposed, in point of simplicity, cost, and above all, safety, and the lecturer described operations witnessed by himself with this system of coal-getting at Shipley Collieries. In concluding, Mr. Abel exhorted those interested in, or entrusted with the working of coal-mines, to spare no pains to test rigorously and fairly the merits of any processes or methods of affording promise of dispensing with the employment of powder in the ordinary way, and thus of securing protection to the miner against combined dangers of fire-damp and dust.

THE INFLUENCE OF TEMPERATURE ON CERTAIN SEEDS

ON regarding seeds of our hardy trees which are sown in autumn, and which do not germinate before the return of spring, we feel forced to admit that however the other conditions may vary, the cause which causes the germination in the commencement of the fine weather is the rise in the temperature, and one is equally tempted to think that the higher the temperature, as long as this rise does not equal that which would destroy the seeds, the more active and pronounced would be the germination. Nevertheless this is not by any means always the case, at any rate in the seeds of the walnut and almond trees. Anxious to germinate some of these seeds in winter, Prof. H. Baillon thought to obtain a more rapid development in a warm house, in which the temperature varied within the twenty-four hours from 15° to 25° (59 – 77 F.), than in a cool house in which during the same time the temperature varied between 5° and 15° (41 – 59 F.), but the trial proved a failure. In the cool-house, in the course of six weeks, the walnuts had stems of about two decimetres in height, whereas the most advanced of those in the warm house had only stems of from two to three centimetres in the fully developed leaves. The experiment was several times repeated. The same quality of earth, and the same quantity of water was used, and the results were the same. After a space of two and a half months the greater part of the nuts sown in the warm house had only roots occasionally well developed, but little or no caulome outside the fruit. Moreover, the greater part of the walnuts which germinated in a house, where there was good bottom-heat, had roots which did not behave like those of walnuts, germinating in the cool house and without bottom heat, the tap root of the latter grew well in length before any egress of the plumule, whereas the tap-roots of those grown in the warm house were early arrested in their development, and this through growing in a very friable soil, consisting of moist sawdust, much less resisting than the sand or the earth of the cool-house, in which the tap-roots developed so well. This was very nearly the same with the almonds, and would seem to point to the fact that in the case of some seeds there is no advantage to be gained by forcing them. Some, like *Eranthis hiemalis*, at whatever period they are sown in the open air, will develop themselves at a fixed time, as it does in January (H. Baillon in No. 39 of the *Bulletin Periodique de la Soc Linn. de Paris*, January, 1882.)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

PROF. HENRY ALLEYNE NICHOLSON has been appointed to the chair of Natural History in Aberdeen, vacant by the removal of Prof. Cossar Ewart to Edinburgh.

DR. SORBY, F.R.S., has been elected president of Firth College, Sheffield.

THE Nottingham University College Committee have appointed Mr. Wm. Garnett, of St. John's College, Cambridge, to the Professorship of Mathematics and Physics, at the College, vacant by the resignation of Prof. Fleming.

SCIENTIFIC SERIALS

American Journal of Science, April.—The wings of pterodactyles, by O. C. Marsh.—Sandstones having the grains in part quartz crystals, by A. A. Young.—Notes on American earthquakes, No. 11, by C. J. Rockwood.—Notes on the electromagnetic theory of light, No. 1, by J. W. Gibbs.—The "timber line," by H. Gannett.—Simple method for calibrating thermometers, by S. W. Holman.—Notice of Fisher's "Physics of the Earth's Crust," by C. Dutton.—Physiological optics, No. III., by W. L. Stevens.—Great dyke of Foyaite or Elœolite-syenite in North-Western New Jersey, by B. K. Emerson.—Notice of the remarkable marine fauna occupying the outer bank off the southern coast of New England, No. 51, by A. E. Verrill.—Determination of phosphorus in iron, by J. L. Smith.

Journal de Physique, March.—On the electro-chemical equivalent of water, by M. Mascart.—Studies on the psychrometer, by M. Angot.—Electric Lighting (concluded), by M. Foussereau. Determination of the ventral segments of sonorous tubes by means of manometric flames, by M. Hurion.—Compensator for measuring electromotive forces, by M. Slouguinoff.—On phosphorographs of the solar spectrum, by M. Becquerel.

April.—On a simple law relative to natural magnetic double circular refraction, by M. Cornu.—Determination of the illuminating power of simple radiations, by MM. Crova and Lagarde.—Measurement of potentials corresponding to determinate explosive distances, by M. Baille.—Study on the combustion of explosive gaseous mixtures, by MM. Mallard and Le Chatelier.—New dry sensitive thermometer, by M. Michelson.

Sitzungsberichte der physkalisch-medicinischen Societät zu Erlangen, 13 Heft, November, 1880, to August, 1881.—On the action of the milk-juice of *Ficus carica*, by A. Hansen.—On the artificial production of double-formations in chickens, by L. Gerlach.—On intra-thoracic pressure, by J. Rosenthal.—On the law of dispersion, by E. Lommel.—A polarisation apparatus from platincyanide of magnesium, by the same.—The germinal plates of Planaria, by E. Selenka.—Contributions to the theory of binary forms, by M. Noether.—Observations on the composition and exchange of material of the electrical organ in the torpedo, by T. Weyl.—On a new way of permanently fixing small anatomical objects for the purposes of demonstration, and preserving them without use of alcohol, by L. Gerlach.—On the compression of drugs, by J. Rosenthal.—On the influence of chemical agents on the amount of assimilation of green plants, by T. Weyl.

Rivista Scientifico-Industriale e Giornale del Naturalista, January 31.—Mode of rendering the Holtz machine more active, by C. Marangoni.—The radiometer and school experiments, by C. Kovelli.—On a Querquedula new to Italy, by A. Fiori.—New applications of the pneumatic method for rapid desiccation of large Orthoptera, &c., by P. Stefanelli.—Preparation of Hemiptera, by G. Cavanna.—Contribution to the study of anthropology of the Southern Provinces, by M. del Lupo.

February 28.—Nephoscope of P. F. Cecchi.—On the synthesis of various organic acids, by Drs. Bartoli and Papasogli, through electrolysis of water and of acid on alkaline, &c., solutions with carbon-electrodes, by P. Guasti.—Differential apparatus for determining the ozone in air, by D. Tommasi.—Observations on the habits and the development of *Æschna cyanea*, Müll., by P. Stefanelli.

March 15.—On *Lebia turcica*, Fab., by F. Piccioli.—Lombard palæontology; fossil fauna of Lombardy, by A. Stoppani.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xv. fasc. iv.—On some fossil insects of Lombardy, by F. Sordelli.—Some theorems on the degenerate forms of ellipsoid of Culmann, by G. Jung.—The double quadratic transformation of space (continued), by F. Aschieri.—Geometrical construction of the universal transformation of the third order, by E. Bertini.

Fasc. v.—Reduction of integrals of algebraic functions to integrals of rational functions, by C. Formenti.—What are the most simple and sure means of radical cure of hemorrhoidal varices? by A. Scarenzio.—Aberrations of the sexual sentiment in a gynæcomastic maniac, by A. Raggi.—On varied systems of forces, by G. Bardelli.

Fasc. vi.—Origin of the *Tractus olfactorius* and structure of the olfactory lobes of man and of other mammalia, by C. Golgi. —Some theorems on the development in series by analytic functions, by S. Pincherle.

Atti della R. Academia dei Lincei, vol. vi., fasc. 7.—On the tombs and dwellings of Iberian families existing in Italy, by L. Pigorini.

Natura, March.—A heat-electrometer, by G. Gandini.—On the origin of electricity of thunderclouds (concluded), by F. G. Nachs.—Alpine meteorology, by P. F. Denza.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, April 29.—Anniversary Meeting.—Prof. W. H. Flower, F.R.S., president, in the chair.—After some preliminary business the report of the council on the proceedings of the Society during the past year was read by Mr. Sclater, the secretary. It stated that the number of fellows on December 31, 1881, was 3213, against 3309 at the same time of the previous year. The total receipts for 1881 had amounted to 25,810*l.*, against 27,388*l.* for 1880. The ordinary expenditure for 1881 had been 24,651*l.*, against 24,753*l.* for 1880; and the extraordinary expenditure 1036*l.*, against 1825*l.* for the preceding year. The sum of 1000*l.* had been devoted to the repayment of the mortgage debt on the Society's freehold premises, which had thus been reduced to 6000*l.* This expenditure had left a balance at the bankers of 1203*l.* to be carried forward for the benefit of the present year. The assets of the Society on December 31 last, after payment of all liabilities, were estimated to amount to nearly 20,000*l.*, exclusive of the value of the library and collection of living animals. As regards the gardens in the Regent's Park, little has been done in the way of special works during 1881, but the buildings and walks had been kept in good repair, and several of the former had been thoroughly repaired and painted. The number of visitors to the Society's Gardens in 1881 had been 648,604, against 675,979 in 1880. The zoological lectures having been well attended during the past year, would be continued during the present season. The number of animals in the Society's collection on December 31 last was 2294, of which 617 were mammals, 1389 birds, and 258 reptiles. Eleven mammals, 17 birds, and 11 reptiles belonging to species new to the collection had been exhibited in 1881, and during the same year a considerable number of mammals, birds, and reptiles of a different species (of which detailed lists were given) had reproduced their kind in the Society's Gardens.—It was moved by Viscount Powerscourt, seconded by Mr. Howard Saunders, that the best thanks of the meeting be given to the Council for their report. The motion having been adopted, the meeting proceeded to elect the new Members of the Council and the officers for the ensuing year, and a formal ballot having been taken, it was declared that Mr. H. E. Dresser, Prof. Mivart, F.R.S., Mr. Henry Pollock, Mr. W. Ayshford Sanford, and Capt. George E. Shelley had been elected Members of the Council in place of the retiring Members; that Mr. F. Du Cane Godman had been re-elected into the Council in the place of Mr. Edward R. Alston, deceased; and that Prof. Flower, LL.D., F.R.S., had been re-elected president, Mr. Charles Drummond treasurer, and Mr. Philip Lutley Sclater, M.A., Ph.D., F.R.S., secretary to the Society until the next anniversary.

Physical Society, April 22.—Prof. Clifton, president, in the chair.—New member, Dr. E. Hopkinson.—The president announced that copies of the Report of the Lightning Rod Committee could be obtained from Dr. Guthrie, Science Schools, South Kensington, price five shillings per copy.—A paper was then read by Mr. W. F. Stanley on the evidence of a flowing liquid moving by rolling contact upon the interior surface of a pipe. In his experimental work on fluids, published last year, the author has endeavoured to show that liquids flowing in a tube move by rolling contact on or past the resistent surfaces of solids, and upon like principles that the moving parts of a flowing liquid move by rolling contact on the more quiescent parts of its own mass, so that in no case is there any element of sliding, gliding, or shearing motion such as is generally assumed. Further experiments tend to support this view in the case of liquids flowing through pipes. The difficulty in the experiments arose from the friction of the pipe impeding the free motion of the particles. The principle was investigated by allowing liquids o various kinds, such as solution of mastic varnish, to flow through pipes, the liquids containing colouring matter, or air particles to assist the eye. The author illustrated the effects by diagrams on the screw.—Dr. W. H. Stone, Mr. Blaikley, Dr. Guthrie, and the President, offered some remarks on the paper.—Mr. J. M. Whipple exhibited the magnetograph curves obtained at the Kew Observatory during the past week, showing the progress of the recent magnetic storms. After stating that two unusually large spots were now passing over the sun's disc, he remarked that although the magnets at Kew were somewhat disturbed on the 14th, they were nearly stationary until the night of the 16th, when, about 11.45 p.m., they became strongly affected, and from then till 8 p.m. on the 17th, the magnetic storm raged. The horizontal component of the earth's magnetic force was at one time reduced more than 0.05 mm. mgrs. below its average value, and the vertical component by about 0.07 of the same units. This happened about 6 a.m. of the 17th. A little after noon of the same day both forces became so increased, that the light spot left the scale of the instrument for nearly two hours. A second period of magnetic disturbance commenced at about 3.40 a.m. of the 20th, and was violent up to 2 p.m., subsiding gradually until 7.45 p.m. of the 21st. During this period, the magnetic force, though fluctuating largely, did not experience such great changes of intensity as were indicated by that of the 17th. Mr. Whipple then alluded to the work of Prof. W. G. Adams, and suggested that sun-spots only produced such effects when cutting certain lines of force, which he imagined might extend for a limited angular distance round the earth's radius vector. Prof. Adams pointed out the desirability of increasing the number of self-recording magnetic observatories, especially in the southern hemisphere, and after mentioning that the French were about to equip such an observatory at Cape Horn, expressed the wish that the Cape of Good Hope Observatory might again be provided with magnetometers.—The Rev. S. J. Perry remarked on the exceptional nature of the storm which he had seen recorded at Brussels, and stated that in Belgium the telegraph service bad been disorganised by it. Attention was also called to the auroral displays in America, and Mr. Lecky, Dr. Guthrie, the President, and others, spoke on the general phenomena of the storms.—It was then announced that the meetings of the Society in May would be held on the 6th and 20th, instead of on the 13th and 27th, as previously announced; also that the Society would hold a meeting at the Clarendon Laboratory, Oxford, on June 17, by invitation of the president.

Victoria (Philosophical) Institute, May 1.—Prof. Reinsch gave the results of his researches into the mode of the formation of coal. The lecture was illustrated by several large drawings and photographs. The professor stated that he had examined with the microscope no less than 2500 sections of coal, and had come to the conclusion that coal had not been formed by the alteration of accumulated land plants, but that it consisted of microscopical organic forms of a lower order of protoplasm, and although he carefully examined the cells and other remains of plants of a higher order, he computed that they have contributed only a fraction of the matter of coal veins, however numerous they may be in some instances, he referred to the fact that Dr. Muck, of Bochum, held that algæ have mainly contributed to the formation of coal, and that marine plants were rarely found in coal, because of their tendency to decompose, and that calcareous remains of mollusks disappeared, on account of the rapid formation of carbonic acid during the process of carbonic action.

Royal Horticultural Society, March 28.—Sir J. D. Hooker, in the chair.—*Savagus floccosus:* Mr. Pascoe exhibited specimens of this beetle from Queensland, attached apparently by a species of *Isaria*, while living.—*Doryanthes Palmeri:* Sir J. D. Hooker exhibited a leaf, some five feet long, and a cluster of flowers from a spike twelve feet in length, bearing a fanicle of flowers, eighteen inches in length.—*Coryanthes macrantha*, exhibited by S. T. Laurence; the fertilisation of which, by insects, is described by Mr. Darwin, in his "Fertilisation of Orchids."

EDINBURGH

Royal Socety, April 17.—The Rev. Dr. Lindsay Alexander, vice-president, in the chair.—Prof. Blackie communicated a paper on the definite article in Greek, with special reference to the revised version of the New Testament. He showed by quotations from classical Greek authors, that the Greeks were anything but particular in the use of the article, and apparently attached little importance to it; and hence a slavish rendering of the article when it occurred into English, not only led in many cases to bad English, but displayed ignorance of true scholarship. This fault, the author maintained, the revisers had in not a few instances made their own.—Prof. Blyth, in a paper on the action of the microphone, pointed out that the action due to the aërial waves of sound directly, and that due to the tremor of the frame-work which supported the microphone, must be carefully distinguished, the latter being probably the source of the jarring that so commonly accompanies telephonic sounds. As the result of a series of ingeniously-contrived experiments, he concluded that the true microphonic action, as far as it related to the transmission of articulate sounds, is due to the direct action of air-pulses upon the temporary minute "arc-lights" which exist as soon as the carbon points are shaken asunder by the tremor of the frame.—Prof. Marshall submitted an account of experiments made by Prof. C. Michie Smith, Mr. R. T. Omond and himself, in reference to the lowering of the maximum density point of water by pressure. The lowering was measured indirectly by calculation from observed thermal effects when the pressure in a mass of water at a given temperature was suddenly diminished from several tons' weight on the square inch to the atmospheric pressure. This thermal effect is a heating effect when the temperature of the water is below that of the maximum density, a cooling effect when above. A thermoelectrical junction let into the pressure apparatus, and connected to a delicate galvanometer, noted the changes of temperature, while the pressure was measured by means of one of Prof. Tait's high-pressure gauges, formerly described. From their first and preliminary series of experiments, they had deduced a lowering of the maximum density point of water by 2° C. per ton's weight increase of pressure.

Paris

Academy of Sciences, April 24.—M. Jamin in the chair.—The following papers were read:—Movements of various parts of a liquid in a vessel or reservoir, whence it flows through an orifice (continued), by M. de Saint Venant.—Researches on the distribution of heat in the dark region of solar spectra, by M. Desains. With a rock-salt prism, he found the position of the cold bands and the maxima always nearly the same. But there was not the same agreement in the relative values of the intensities of successive maxima and minima (especially in the region of great wave-lengths). The maxima were much greater in 1882 than in 1879 (doubtless owing to dryness of the air).—Memoir on the temperature of the air at the surface of the ground, and of the earth to 36 m. depth, also of two pieces of ground, one bare, the other turf-covered, in 1881, by MM. Becquerel. The mean air-temperature, 11°·15, is higher than in the two immediately preceding years.—On quarantines at Suez, by M. de Lesseps.—Separation of gallium, by M. Lecoq de Boisbaudran. He uses advantageously cupric hydrate, instead of carbonate of baryta or lime, for precipitation of galline; the copper is easily eliminated with sulphuretted hydrogen.—Report on a memoir relating to the hygienic and economical properties of maize, by M. Fua. M. Fua proves the value of maize as food; maladies attributed to it have been really due to badly kept and diseased maize.—On hypercycles, by M. Laguerre.—On the theory of uniform functions of a variable, by M. Mittag-Leffler.—On Fuchsian functions, by M. Poincaré.—Solution of the general problem of indeterminate analysis of the first degree, by M. Méray.—The minima of sun-spots in 1881, by M. Ricco. The northern hemisphere was observed (at Palermo) without spots, 23 days; the southern, 94 days. There were 12 periods of minima in the north, and 18 in the south. The intervals of minima differ little from the time of a solar rotation. A certain stability of minima thus indicated, especially in the northern hemisphere, was confirmed by observations of longitude.—On the actinic transformation of Foucault mirrors and their applications in photography, by M. de Chardonnet. A plate of rock crystal, silvered so as to be opaque to sight, forms a filter, permeable exclusively by dark rays of short wave-length, and which may be used for photography without intervention of visible light. Very white crown glass or thin Saint Gobain glass may be used instead of rock salt.—On magnetic perturbation, by M. Mascart. A magnetic storm of large extent seems to have begun (after some preliminary indications) on the night of April 13, and continued a week or more; strong shocks occurred on the 16th and 20th.—Winter of 1881-1882 at Clermont and at Puy-de-Dôme, by M. Alluard. These stations showed interversion of temperature with altitude on 78 nights in four months (November to February), or nearly two-thirds; the minima on Puy-de-Dôme ranging from 7 to 13 degrees above those at Clermont. New proof was had of the rule that whenever an area of high pressures covers central Europe, and especially France, the interversion in question occurs. M. Faye, referring to the fact that Mont Blanc is sometimes seen from Puy-de-Dôme, distant 280 km., suggested observation of geodesic refraction between them.—On the equivalent of carbon determined by combustion of the diamond, by Prof. Roscoe. Representing O by 15·46, C becomes 11·07.—On the decomposition of salts of lead by alkalies, by M. Ditte.—Action of sulphuretted hydrogen on solution of sulphate of nickel in the cold state, by M. Baubigny.—Researches on ozone, by M. Maillefert. He describes its action on sulphur, selenium, tellurium, sulphides, and some organic matters.—On the absorption of volatile bodies with the aid of heat, by M. Schlœsing. He illustrates this by several experiments; *e.g.* powders of carbonate of ammonia pass into a small tower of coke, sprinkled with dilute sulphuric acid; a part of the alkali is carried beyond. If the temperature be raised to 100°, the absorption is total, and almost instantaneous. M. Schlœsing proposes to apply the principle to determination of nitric acid in the atmosphere.—On the oxidation of pyrogallic acid in an acid medium, by MM. Clermont and Chautard.—On the insoluble modification of pepsine, by M. Gautier.—On nuclei with intense polychroism in dark mica, by M. Lévy. These are due to zircon.—On the action of permanganate of potash against accidents from the poison of Bothrops, by M. Couty. His conclusions, from experiment, are adverse to use of the permanganate as antidote.—On the abyssal malacological fauna of the Mediterranean, by M. Fischer. From 555 m. to 2660 m., about 120 species of mollusca were dredged, of which only about 30 are really abyssal. The number of species diminishes sensibly with the depth. All the deep species are also found in the Atlantic.—On some attempts at hybridation between different species of Echinoideæ, by M. Kœhlen. These were successful, *e.g.* in the case of a Spatangus and a Psammechinus.—On some points of the anatomy of Holothurians, by M. Jourdan.—On the pyloric ampullæ of Podophthalmate crustaceans, by M. Mocquard.—On the vitality of trichinæ encysted in salt meat, by M. Fourment. In salt meat prepared fifteen months back were live trichinæ, which were fully evolved in the alimentary canal of a new host, and caused death.

CONTENTS

THURSDAY, MAY 11, 1882

BRITISH FOSSIL CEPHALOPODS

A Monograph of the British Fossil Cephalopoda. Part I. Introduction and Silurian Species. By J. F. Blake, Esq., M.A., F.G.S., Professor of Natural Science in University College, Nottingham. (London: J. Van Voorst, 1882.)

FOR the first time has just appeared Part I. of a monograph upon the British Palæozoic Tetrabranchiate Cephalopoda, and important as this group of Mollusca has ever been regarded by all palæontologists and badly as such has been wanted by all students of British Palæozoic geology, no one has hitherto attempted any history of this group for Britain. Barrande has elaborately done so for Bohemia and De Koninck for Belgium, both have extensively written upon the older Cephalopoda [Cambrian, Silurian, Devonian, and Carboniferous]. Barrande in his exhaustive work illustrates no less than 1620 Silurian species. De Koninck in his last important work upon the Carboniferous Limestone of Belgium enumerates 170 species, amongst them many new forms and many common to British strata. Prof. J. F. Blake intends completing this history of the British Palæozoic Cephalopoda in two volumes. The part now issued, being part or vol. i., treats only of Silurian species. No less than 244 quarto pages and 31 plates are devoted to the description of 11 genera and 6 sub-genera, and 143 species. The great genus *Orthoceras* being illustrated by 76 species, and its 4 sub-genera by 6 species, *Cyrtoceras* 23 species, *Poterioceras* 2, *Gomphoceras* 11, *Phragmoceras* 7, *Ascoceras* 3, *Nautilus* 4, its sub-genus *Trochilites* 3, *Trochoceras* 12, *Lituites* 2, *Ophidioceras* 2, and *Goniatites* (?) 2 species. These 143 species range from the Tremadoc Rocks, of the Cambrian series, to the Tile-stones of the Upper Ludlow. Forty of the 145 species also occur in Europe and America, or 32 are common to Europe and 6 to America, thus showing the wide distribution of certain genera and species. Thirty-one plates accompany the letterpress or text, every species being figured, and more than 2000 specimens have been examined by the author having reference to the history and description of these 143 species. Prof. Blake has given on pp. 233-6 a table of the distribution in time of all the species, and on p. 237 a condensed table showing the "growth, culmination, and decay of the genera and group." These two tables are suggestive, and the outcome of their study shows that there were two maxima of individual abundance, one occurring in the older group of rocks, the Caradoc or Bala, and the other, in the Lower Ludlow, yet we feel assured that there was no real diminution or falling off in the variety of forms between these two deposits. The tables clearly show that the species in the Wenlock Limestone were (or are now found to be) comparatively few as compared with those in the shales above and below, and would indicate that the Cephalopoda of the Wenlock seas were not commonly frequenters of clear and shallow waters, but were partly pelagic and possibly gregarious in more or less turbid waters, as indicated by the impure sediments composing the Ludlow shales.

Prof. Blake has proposed a classification of the Nautiloidea based upon the general form of the shell, and having a variable siphuncle. He places all the Palæozoic forms under four groups: 1, the *Conici;* 2, the *Inflati;* 3, the *Spirales;* and 4, the *Irregulares.* The 18 genera being naturally distributed through these four groups.

Group 1. The Conici.—Receives the genus *Orthoceras,* with its 5 sub-genera: *Endoceras, Actinoceras, Tretoceras, Conoceras,* and *Gonioceras,* all having straight conical shells; also the curved genus *Cyrtoceras* with its sub-genus *Piloceras.*

Group 2. The Inflati.—Receives the well-known genera *Poterioceras, Gomphoceras, Phragmoceras, Ascoceras,* and *Glossoceras,* all possessing species with curved inflated shells, and contracted apertures.

Group 3. Spirales.—Those species with the whorls in contact, of simple form and considerable curvature, illustrate this group. The characteristic genera are *Trocholites* (Silurian), *Clymenia* (Devonian). *Aturia* (Tertiary and Cretaceous), *Discites* (Carboniferous), and *Nothoceras* (Silurian), a Bohemian form.

Group 4. Irregulares.—The genera comprising this group are all unsymmetrical in form, and greatly curved, the genus *Lituites, Trochoceras,* and *Ophidioceras* illustrate this division.

Prof. Blake does not lay much stress upon the contraction of the aperture in the shell classification, although it is important and recognised by Barrande as of much significance, doubtless other features in the general structure of the shell weigh equally in the determination of species. Such variations as are seen in rare or little known forms become matters of individual opinion to the species maker. As no Dibranchiate Cephalopod is known, or has no representative in the Palæozoic rocks, they may be dismissed as having no place or value amongst the Silurian species; therefore the whole group, whose entire history Prof. Blake has so ably described, belong to the Tetrabranchiata in its two great families, the *Nautilidæ* and *Orthoceratidæ,* especially the latter. Most, if not all, naturalists now agree in separating or excluding the *Bellerophons* from the Cephalopoda, although Prof. McCoy, Ferrussac, D'Orbigny, Latreille, and Sowerby formerly believed they belonged to the "Argonautidæ," and so placed them.

There is still difference of opinion as to the exact limits and sub-divisions of the order Orthocerata. Barrande has given all the known classifications, and the characters on which they have been founded by different authors. They are based (1) upon the position of the siphuncle; (2) the form of the suture; (3) the involutions of the shell; (4) the form of the aperture; (5) the symmetry or asymmetry of the shell; (6) the direction of the septa: (7) the simplicity or complexity of the siphuncle.

In Palæozoic forms the siphuncle played a very important part in the life and history of the species, being simple in one genus, complicated in another, dorsal in one, and ventral in another, and medial in some; the genera and species have been mostly founded on these changes and elements.

The earliest group to make its appearance in time was that of the Orthocerata, and out of it from the peculiarities of the siphuncle and shape of transverse sections, have been formed or established six genera, viz. *Gonioceras, Tretoceras, Endoceras, Actinoceras, Bathmoceras,* and *Bactrites,* all these constitute one natural group, placed by Mr. Blake under the "*Conici*," diverging from this and more restricted in time, having variously shaped apertures, and singularly inflated, fusiform, pyriform, or flask-shaped shells, are the genera *Phragmoceras*, *Gomphoceras*, *Poterioceras*, and *Ascoceras*, and placed under the group "*Inflati*" by the author. The other two groups of the Nautiloidea—the *Spirales* and the *Irregulares*—possess so great a shell curvature that they assume the form of whorls, which may or may not be in contact. This fact appears of sufficient importance to justify Mr. Blake in regarding it as the basis for establishing the group "*Spirales*," in which is placed the genera *Nautilus*, *Gyroceras*, *Trochilites*, and *Clymenia*, &c., finally through peculiarity of form, such as want of symmetry, or loss of, or changes in curvature, are many of peculiar aspect, which Mr. Blake places under the group "*Irregulares*," the genera contained in which are *Trochoceras*, *Lituites*, *Ophidioceras*, and *Cryptoceras*. These researches have led to the construction of the table of classification above given.

Prof. Blake commences his systematic description of the species with the genus *Orthoceras*. No less than 70 species in this genus are described by the author, ranging from the Tremadoc rocks to the uppermost Ludlow beds (the Tile-stones). The species mostly abound in the Bala beds, the Wenlock shales, and the two Ludlows. The literature or bibliography of the species of the Orthocerata, their descriptions, and that of the 5 sub-genera is of the greatest value, and an addition to our knowledge of this oldest known genus in the British rocks; Cyrtoceras being its only associate in the Tremadoc beds. The sub-divisions of the genus by Quenstedt, M'Coy, De Koninck, and Barrande are given. Mr. Blake adopts Barrande's views and grouping of the Orthocerata into two groups: (1) the *Breviconcs*; and (2) the *Longicones*. The latter, which is very numerously represented, Mr. Blake divides into the *Annulati*, the *Angulati*, the *Lineati*, the *Imbricati*, and lastly the group *Leves*. In this latter group is temporarily placed all species whose *external* surface is unknown. Then follows concise but clear descriptions of the five sub-genera—*Actinoceras*, *Endoceras*, *Tretoceras*, *Conoceras*, and *Gonioceras*. For the first time we now have the 70 British species of Orthocerata brought together, and most ably described and figured; 3 species belong to the group "*Brevicones*," and 67 to the group "*Longicones*." Of these, 20 species fall under the group *Annulati*, 6 under the *Angulati*, 13 under the *Lineati*, 7 under *Imbricati*, and 22 in the group *Leves*. We are now able to investigate all the known species of this extensive Palæozoic genus, and no student need be at a loss to determine, either through original description and drawing, or the reproduction of type species, any forms that he may meet with in the Silurian rocks of the British Islands. The author's plan of first describing in every instance the type of the species, is of extreme value, as it at once (if a known species) clears up its history; this with reference to the original figure and description by the author, and its reproduction in the monograph, ensures and affords every chance of right determination. Following the "type" is the general description, then its relation to other known forms, British or foreign, followed by its distribution in time or space; this plan is implicitly followed throughout the entire volume—it is clear, definite, and systematic. The next important group described by Mr. Blake are the Cyrtoceri, numbering 22 species. These curved Cyrtoceri Deshayes termed Campulites, restricting the term to those species having the siphuncle on the inner side. Goldfuss, however, regardless of the position of this organ, named them Cyrtoceras; Billings, De Koninck, Sandberger, Giebel, and Barrande have all proposed divisions for the classification of Cyrtoceras. Blake follows Barrande, who divides them into two series, according to the position of the siphuncle: (1) the *Exogastric*, in which that organ is external; and (2) *Endogastric*, in which it is internal. Prof. Blake proposes a third grouping for these species, in which the siphuncle is near the centre, calling it "Mediogastric." The Bala, Wenlock, and Lower Ludlow beds contain most species of Cyrtoceri. The species *C. precox*, from the Tremadoc beds of Garth, in North Wales, and from Llanerch in Pembrokeshire, with *Orthoceras sericeum* are probably the oldest forms known.

The singular genus Gomphoceras receives much careful analysis from Prof. Blake. Six of the 11 species are new, and there appears to be good reason for their establishment; with one exception the species are all (10) Upper Silurian, 8 of the 11 are in the Lower Ludlow beds, and 5 in the Wenlock Limestone. Two quarto plates are devoted to this remarkable genus. Four of the 7 species of Sowerby's genus Phragmoceras are also new, and for the first time figured. Like Gomphoceras this genus is chiefly Upper Silurian, the Wenlock and Ludlow strata being characterised by them. Mr. Blake adds much to our knowledge respecting the species of the genus Ascoceras of Barrande, hitherto little known or understood; the species in Britain are confined to the Ludlow rocks.

The group Spirales, illustrated by the genus Nautilus and its sub-genera, receives ample and critical notice, and shows how varied have been the views of naturalists upon the affinities of this old genus, established by Breynius in 1732. The value of the sub-genera in this as in all the large groups is of much significance in tracing the history of the obscure forms classed under the genus Nautilus or *Nautiloid* remains in the Lower Palæozoic rocks. Five of the so-named genera—Trocholites, Clymenia, Aturia, Discites, and Nothoceras are placed under the genus Nautilus as sub-genera. Mr. Blake gives Quenstedt's, D'Orbigny's, and De Koninck's classification or sub-divisions, and suggests one of his own. Quenstedt proposed to subdivide the genus Nautilus into 8 groups: (1) the Insecta, (2) *Clymenia simplices*, (3) *Clymenia angulosæ*, (4) the Moniliferi, (5) Bisiphites, (6) Simplices, (7) Undulati, (8) Aganides.

This and the classification by De Koninck ("Terr. Carb. de Belg."), in which he partly follows Quenstedt, are the only two hitherto recognised divisions of the genus. The Belgian Professor places his Palæozoic species under the following six heads: (1) Imperfecte, (2) the Striati, (3) the Radiati, (4) Lævigati, (5) *Clymeniæ simplices*, and (6) *Clymenia angulatæ*; four of the six being those of Quenstedt. Prof. Blake proposes or suggests a simpler grouping. No. 1, *Simplices*, illustrated by the sub-genus *Trocholites*; 2, the *Radiati*, those species having radiating, sigmoidal, or angular ribs; 3, the *Ornati*, variously ornamented, chiefly Carboniferous, equivalent to M'Coy's sub-genus *Temnocheilus;* 4, the *Sinuosi*, those with sinuous sutures; and 5, those species with nummuloid siphuncles (Trias only).

Probably only three species of Nautilus occur in the Silurian rocks—*Nautilus quadrans*, *N. Holtianus*, and *N. Bohemicus*. This last-named species appears to be the *Lituites Biddulphi* of Sowerby (1838); but his insufficient description, in the "Sil. Syst." of Murchison, prevents true identification. They are all three Upper Silurian forms. The Lower Silurian rocks of Newfoundland and Canada have yielded eleven species. In the Carboniferous strata Nautilus attains through Discites its maximum development. In the Permian only one species is British, and three American, and is now the only living representative of the Tetrabranchiata. The sub-genus *Trocholites* (three species are Lower Silurian. These six forms are the only *true* Nautiloidea in the Silurian rocks.

The last group (4, the *Irregulares*) in Mr. Blake's classification receives three genera: *Trochoceras*, with 12 species; *Lituites*, 2; and *Ophidioceras*, 2 species. We have no representative of either the *Endogastric* or *Exogastric* group of Barraude in this country. American and Swedish Lower Silurian species are somewhat abundant, in Britain it is chiefly an Upper Silurian genus. Of the 12 species known 8 are Upper Silurian—Wenlock and Ludlow—and the Llandilo, Bala, and Llandovery beds yield the remaining *Trochoceri*. Five of the 12 species are *new* to Britain, described and figured by Prof. Blake for the first time. The two type species—*Trochoceras* (Lituites) *cornu-arietes* (Sowerby), and *Trochoceras* (Lituites) *giganteum* (Sowerby)—are admirably refigured and described by Mr. Blake, the general descriptions adding to their specific value, and the determiuation of Bohemian forms of Lituites in Britain materially adds to the correlation of the two faunas. Barrande's genus Ophidioceras (*Lituites, auct.*) seems to have been recognised by Mr. Blake; it differs from typical Lituites by the whorls being accurately in contact. The *Lituites articulatum*, Sow., was long ago figured as Lituites in the "Sil. System," p. 622, t. 11, f. 5, and adopted by Salter. The straight ribbing and band distinguishes this genus from Lituites. This volume concludes with general observations, and highly suggestive many of them are. Prof. Blake endeavours to throw some light upon the laws which govern the appearance and disappearance of forms of life, and into the nature of those groups of individuals to which we assign the term species.

Mr. Blake prepares a table, condensed from the larger and preceding one on pp. 233-236. This condensed table shows the numerical value of the species occurring in the 11 genera, and ranging through the ten formations or horizons, thus showing their increment, decrement, and stratigraphical distribution. Both tables show three maxima in the Ludlow, Wenlock, and Bala beds—in the Ludlow 65 species, the Wenlock 43, and the Bala 39. Mr. Blake does not believe that there was a corresponding falling off between these epochs; he draws conclusions from the comparative fewness of species in the *Wenlock Limestone* as compared with the Ludlow shales above and Wenlock shales below that formation. Of the four groups given the *Conici* first appear, and constitute the bulk of the Lower Silurian fauna, 31 species occurring in the Bala rocks [the Tremadoc only yielding two species, the Llandeilo 9, and the Lower Llandovery 8, or 19 for the three horizons]. The *Conici* and *Spirales* are the only two groups which continue on in time or range into the higher divisions of the Palæozoic rocks (the *Devonian* and *Carboniferous*), the *Inflati* being represented by *Poterioceras*, &c., in the Carboniferous series.

Mr. Blake next considers the characters of the individual genera and their appearance in time, but somewhat begs the question to suit his particular view upon evolution; it surely can hardly be safe to speculate upon any particular curve or part of the curve in any particular genus, to argue for descent through evolution, other conditions not known. Neither *Cyrtoceras precox* or *Orthoceras sericeum*—which are the oldest species known in Britain —"are transitional forms, both being well characterised," and it is questionable whether the group which has been longest in existence in a given area, will there most abound, many physical conditions may tend to prevent that, "though we grant that possibly the greater the abundance of individuals, the greater is their chance of preservation in the rocks, the nature of the deposit admitted.

In the paragraph on p. 239, having reference to the genera Cyrtoceras, Phragmoceras, and Gomphoceras, more evidence is wanting before we can draw any conclusion as to priority of appearance, or show that those having the siphuncle internal (Endogastrica) appeared first or preceded the Exogastrica (with the siphuncle external); it is true we must take the evidence as it stands, or as we find it; it is, however, wiser not to theorise upon such slender materials.

Prof. Blake next notices and discusses the question of species (pp. 239-243), and has pronounced opinions upon this vexed, complicated, and philosophical question, naturally the old idea of the independence of species is rejected. Mr. Blake adopts all through his book the method of "actually describing a type-specimen around which the other forms designated by the same name may cluster." When the original type has not been seen or found, a type is selected to which others are compared. In attempting the explanation of the phenomenon of distinct species or specific groups, it is well known that two theories are now held: (1) that which considers each species a "special creation, though inexplicable"; or, (2) "that which asserts the development of one from the other by a process of evolution." Mr. Blake appeals to palæontology to show, through its researches, the gradations between one species and another. The result to Mr. Blake's investigation in this and other groups is against "fixity of species." He states, that "if species were such definite entities as they were once supposed to be, they ought to be much more easily distinguished than they are, and that the many variations of form which will be found included, and necessarily included under one specific title, whose 'general description' thereby becomes one of considerable latitude, show that different specimens are not so closely linked as that theory would imply." On the other hand, "Does this present study," asks Mr. Blake, "give any positive aid to the theory of evolution?" He fails to see any reasonable solution or answer. It is evident that among "the many forms which flourish in any one epoch, it must be impossible to say with certainty which was the descendant of any particular form in the preceding epoch, especially as the intervening links are, in all probability, absent."

Mr. Blake selects certain species of Orthocerata which may have been produced by descent; at the least it is only supposition, and he states that there is no proof that they are actually so connected, but to the general theory of evolution—which merely states that every form of life has been developed from a preceding one nearly allied to it—the present study affords no contradiction or difficulty, but affords aid—which if not so great as could be desired, is yet as much as could be expected. In the present study of the Palæozoic Cephalopoda we have a fair representative of a successive fauna of the same class, and the species are grouped round a series of central types; and so long as the surrounding circumstances remain constant and the same, the process of evolution by indefinite variation and survival of the fittest should either be uniform, and leave relics having no special grouping, or it should cease when the best adaptation to the surrounding circumstances or conditions had been acquired. These views are expressed and carefully argued by Prof. Blake, in the concluding pages of his work. "The great defect," writes Mr. Blake, "of the theory of natural selection is that it leaves the original variation, which is the basis of the whole to chance; chance variations are not likely to lead to any law." "The part which it has effectually performed is to show how variations of the individual may produce permanent changes in the species, and thus break down the idea of the fixity and independence of the latter." "We are, perhaps," says the author, "as yet too dazzled by the brilliancy of the theory to perceive its inadequacy as a complete account of life or to place it as one link only in the chain of explanations."

The "General Observations" of Prof. Blake on pp. 237-44 are a fitting termination to the laborious part undertaken by him in describing the 145 Silurian species. The work has been most carefully and honestly done, and now for the first time we possess a complete monograph upon the Tetrabranchiate Cephalopoda of the oldest Palæozoic rocks; no less than 31 quarto plates illustrate the species, and all are drawn life-size. Mr. Blake has examined 2000 well-characterised specimens, and has visited all the museums and private collections in Britain likely to contain materials for his work, and as he remarks, the work includes a description of every known specimen so far as it presents any available characters.

The fragmentary state of nine-tenths of the specimens collected, demanded from the author the most careful examination, whether by comparison or through description of specimens, and those who know the condition of Silurian Cephalopoda as occurring in this country will indeed appreciate the critical labour of Prof. Blake; he has rendered great service to palæontology. The book was the one want, as a completion to the works of Murchison, McCoy, Salter, and Sowerby in Britain; a companion to the grand monographs by Barrande upon the Cephalopoda of the Silurian Rocks of Bohemia, also a fitting accompaniment to the monograph by De Koninck upon the same group for the Silurian and Carboniferous Rocks of Belgium. No library devoted to natural science should be without this first volume, and no student of Palæozoic species can do without it. No group of invertebrata are of such importance to the stratigraphical geologist as the Cephalopoda; in Britain alone the Palæozoic species number nearly 400, and in Bohemia the *Silurian Cephalopoda*, as described by Barrande, reach the great number of 1600, the Devonian species 500, and the Carboniferous species of Europe 350 species; these totals will at least give some idea of the life and distribution of this class of mollusca through time in Europe, and as Prof. Blake's first volume only treats of the Silurian of Britain, we wish him further success in his continued work upon the British Devonian and Carboniferous species, the fossil forms in which require the most minute, careful, and detailed study. R. E.

OUR BOOK SHELF

Social History of the Races of Mankind. Fifth Division: Aramæans. By A. Featherman. (London: Trübner, 1881.)

We do not like to discourage a student who has evidently a zeal for knowledge, and must have given great labour to compiling the comprehensive account of human society, of which this volume is the first instalment published. But we are bound to say he does not seem alive to the differences of value among the travellers' books of which he gives a list at the end of each section, and out of which he has pieced together extracts describing Jews, Arabs, Egyptians, &c. Thus some statement about the Copts may be out of Lane's "Modern Egyptians," or it may be out of Miss Lot's "Nights in the Harem," and the reader would rather like to know which is which. Mr. Featherman writes in his preface: "The facts have been selected with critical discernment, and no doubtful or incredible statements are admitted in the text, unless controverted in a footnote." Then follows an introduction, which begins: "The primæval man did not spring from a single stock, or from one ancestral type. He arose under varying conditions, and at different geological periods. The initiatory forces of nature which caused his primitive development, existed in the same degree in all the isothermal regions of the earth, and whenever the favourable circumstances were capable of producing and fostering into maturity the human animal, there he appeared," &c., &c. Putting preface and introduction together, it is plain that the author's critical discernment does not enable him to know a doubtful statement when he sees it, even when it is of his own making. In fact he does not quite know where he is, or a casual look into his volume would not show the ancient Egyptians classed among the Aramæan or Semitic nations without mention of their great physical difference from Jews and Arabs, nor would there be found in the account of the Egyptian religion a mention of Isis as being Ceres and Proserpine, mother and daughter at once. The book deserves a place on the library shelf, and will be useful to students, especially for its descriptions of Druses, Talmud Jews, and other little-known minor groups. It is doubtful if its reception by the public will justify the series being continued; but in case it goes on, the materials ought to be more carefully selected, and references given.

Commercial Organic Analysis. By A. H. Allen. Vol. II. (London: Churchill, 1882.)

The first volume of Mr. Allen's work treated of cyanogen compounds, alcohol derivatives, phenols and acids; in this second part the very useful and practical character of the work has been fully maintained in the description of the properties, tests and assay of the hydrocarbons, fixed oils, and fats, sugars, starch and its isomers, alkaloids and organic bases, &c. The author has omitted, as stated in his preface, all mention of dyes and colouring matters, coal-gas, and animal products, on the ground that their consideration would have inconveniently increased the size of the work. This is somewhat to be regretted, as they are matters of quite as much importance as fixed oils, &c., to which a long chapter is devoted, and their inclusion would have certainly increased the value of the book for all general purposes.

The chapters on paraffins, terpines, and homologues of benzene are very clear, and in many cases detailed methods of assay, as, for instance, with benzene, anthracene, &c., are given that will be found of practical value.

A large chapter is devoted to the description of methods of examination of fatty oils and fats employed in the soap manufacture, and the same section also gives considerable general information respecting varieties of soap with methods in some cases improved by the author, for the analysis of soaps ; in particular a tabular arrangement of analysis of a soap on p. 242.

About 100 pages are devoted to the important subject of sugars, and in this space we find an admirable condensation of methods in use, both optical and chemical, for the detection and determination of the various varieties of sugars met with commercially. The optical portion is prefaced by some short remarks on construction, and varieties of polometers in use, which might with advantage have been somewhat extended.

All the methods given in this section are up to date, and cannot fail to be of use not only to the practical man, but to the student.

The chapter on the alkaloids is also a very complete compilation of methods of detection, &c., that have been proposed and found to be reliable up to date. No doubt the book will be found valuable as a reliable compilation of methods, &c., as such, saving much time and trouble in referring to the original publications. The author is an eminently practical chemist, and in his preface to the first volume seems to deride the teaching of "ultimate organic analysis" and the "ringing the changes on the everlasting-chloro-bromo and nitro derivatives of bodies of the aromatic series."

The quality of Mr. Allen's production atones somewhat for this ebullition, for his book requires a considerable amount of theoretical knowledge to be possessed by the user ; and it is very desirable, if we are to maintain a position as chemists at all, that the cant about "purely practical work" should cease, and a more thorough foundation in theoretical chemistry be imparted to students, so that they may become reliable practical men, and not mere machines for manipulating test-tubes.

Nordenskjöld's Arctic Voyage Round Asia and Europe. A Popular Account of the North-East Passage of the *Vega*, 1878-80. By Lieut. A. Hovgaard. Translated from the Danish by H. L. Brækstad. Maps and Illustrations. (London : Sampson Low and Co., 1882.)

LIEUT. HOVGAARD, of the Danish Navy, was one of the most efficient members of Baron Nordenskjöld's well-selected staff on board the *Vega*. When he returned from the remarkable voyage, he very naturally felt impelled to tell his countrymen how he had fared and what he had seen. This he has done in a pleasant and popular style, utilising to some extent the material collected by his chief. Lieut. Hovgaard, while dealing mainly with its lighter aspects, gives a fairly complete sketch of the voyage. The translation is well done, and the translator deserves special credit for the intellgible way in which he has rendered Russian names. The illustrations are not up to a very high mark.

The Sphygmograph; its History and Use as an Aid to Diagnosis in Ordinary Practice. By R. E. Dudgeon, M.D. 8vo., pp. 72. (London : Baillière, Tyndall, and Cox).

THIS book may be of some service to beginners, as it gives rudimentary instruction in the use of the instrument, but this is all it does. The history is carelessly written, the account of the indications given by the sphygmogram is imperfect, and the deductions drawn are sometimes, we think, incorrect. From a curve in the upstroke the author concludes that the ventricular contraction is of a peristaltic character, a conclusion which would be most important if it were correct. But he does not at all take into consideration the great probability that this curve is due to instrumental error, inasmuch as it does not appear in the tracings obtained by Marey's sphygmograph, in which the connection of the writing-lever with the artery is more perfect than in Dr. Dudgeon's instrument. The chief value of the book consists in the description and directions for applying Dr. Dudgeon's sphygmograph, which certainly possesses the great advantage over other instruments, that it is much cheaper, and can be applied much more quickly, and with much less trouble.

A Great Mathematical Question. By T. Wakelin, B.A. (Melbourne : G. Robertson, 1881.)

A PAMPHLET of 16 pp., with a coloured diagram, the object of which is to show the fallacy of the *measure* of kinetic energy. It is an account of the old dispute originated by Leibnitz, and about seven pages are taken up with extracts from Whewell's "History of the Inductive Sciences" (vol. ii. pp. 68-70) ; *Penny Cyclopædia*, "Vis Viva" ; *Encycl. Brit.*, "Energy" ; Balfour Stewart, "Heat" (pp. 301-4) ; and Routh's "Rigid Dynamics" (pp. 260, 263, 270-1), with a reference to Todhunter's "Mechanics" (pp. 210, 211). We would suggest, as additional references, Clerk Maxwell, "Matter and Motion" (§ lxxvii.), and Tait's "Recent Advances in Physical Science." Mr. Wakelin concludes : "It will therefore be seen that the *distance* through which a body *falls* during the time of falling, is not a measure of the work of the force of gravity during that time. This, of course, means that the ordinary measure of the kinetic energy of a mass in motion is an erroneous one."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Existence of a Voice in Lizards

THE letters on the existence of a voice in lizards, by M. Pascoe and S. P. Oliver, in NATURE, vol. xxv. pp. 32, 174, gave me much pleasure, being a confirmation of observations first made and published by myself in 1874, but doubted in different quarters. In my paper, "Zoologische Studien auf Capri, II. Lacerta muralis coerulea, ein Beitrag zur Darwinschen Lehre, Leipzig, Engelmann, 1874" (p. 20), I have laid down the result of my observations, in the first instance, concerning the habits of the bluish-black wall-lizard, *Lacerta muralis cærulea*, discovered by me on the Faraglione rock near Capri, and subsequently on those of other wall-lizards. There, I say : "To the harmlessness (or fearlessness, mentioned previously) of the blue inhabitant of rocks—*Lacerta muralis cærulea*—I owe the discovery of the animal's intonating capacity, a peculiarity generally ascribed among reptiles to the geckoes and chamæleons, but never observed in wall-lizards till now."

One summer-day I heard in the room where I kept a cage of lizards a peculiar sound, similar to the piping of a nestling, only softer. Having listened attentively, I was surprised to find it proceeding from the throat of one of my male blue lizards. Leisurely resting on a stone, the animal repeated the sound a dozen times, perhaps at intervals of about a quarter of a minute, each time opening its mouth a little way. For several consecutive weeks I noticed the same kind of voice in other individuals of both sexes, after which period I did not hear it for months. A series of these calls were taken down by me from ear ; I give them here : "chri, bschi, riä, bi, bschiä."

Among these slightly protracted notes the ch, sch, i, and ä predominated. As to their possible meaning I am still in the dark; I was not even able to discern whether they were to express a sensation of pleasure or comfort, pain, or passion. The animals seemed to be in quite a normal condition. As I shall relate further on, I overheard afterwards a common wall-lizard of Capri, grown blind by conjunctivitis, in the act of producing the same sounds.

After it had been attempted to reject my statements, without any reasoning, indeed by declaring the voice described by me to have been the effect of a rheumatic affection of the mucous membranes, which the Italian lizards had contracted in our cold German climate, I happened to hear the same sounds from a lizard under circumstances wholly excluding every supposition as to its being an abnormal voice. I have shortly communicated the fact in my paper "Untersuchungen über das Variiren der Mauereidechse, ein Beitrag zur Theorie von der Entwicklung aus constitutionellen Ursachen, sowie zum Darwinismus," in Troschel's *Archiv für Naturgeschichte*, xlvii. Jahrgang, 1881, and separately in Nicolai's Library, Berlin, 1881 (pp. 66-68), I quote the following passage:—

"In 1877, having ordered a man to search the middle Faraglione rock for lizards, I waited for his return in a little boat at the foot of the rock. After a while, the man came down with a number of captured lizards tied up in his pocket-handkerchief. I was going to take a specimen of *Lacerta muralis cærulea—Cærulescens mihi*—which he had just released, in my own hand, when it uttered repeatedly, in swift succession, a series of very sharp tones, sounding like 'bschi,' and reminding me of the hoarse piping of a mouse or a young bird."

Moreover, I mentioned that Dugès already tells us of *Lacerta Edwardsii*, a little lizard peculiar to the shores of the Mediterranean, that it is apt to utter a sound resembling the creaking of a Cerambyx. And he further reports that *Lacerta ocellata*, a large lizard of the south, when angry, will expel its breath so vehemently that a sort of voice is produced. And M. H. Landois, of Münster, at my request, informed me last year that *Lacerta viridis* was able to utter a distinctly hissing or blowing sound. These reptiles on being approached on a hot summer day, would rush furiously at their enemy, at the same time making use of their voices, so that they were distinctly heard.

Excepting the few instances above mentioned, in which the existence of voices in lizards has been observed, I am not aware of any corroborative evidence preceding that discovery, a circumstance which is easily explained by the general taciturnity of the animal, which but rarely makes use of its voice.

On the other hand, the *Tapoya Douglasii*, a kind of lizard living near the Oregon Lake, when irritated, hisses very audibly. In like manner are the Iguanas reported to hiss and blow on being caught. TH. EIMER,

Professor of Zoology in the University of Tübingen

Sea-shore Alluvion--Langley Point

THIS spit of shingle, thrown up under the lee of Beachy Head and to the eastward of Eastbourne, is formed, like Dungeness, to windward of what was anciently a large tidal estuary forming Pemsey or Pevensey Haven. At the Roman period the mound on which stand the ruins of the castle, was washed by the sea. The windward supply of shingle forming this ness came from the beach at Brighthelmstone, a fortified town below the cliff, in Elizabeth's reign, on the site of the chain pier, gradually undermined by the sea, and not wholly destroyed until the end of the last and commencement of the present century, and the growing out of Langley Point is coincident in time with the destruction of the Brighton beach as its subsequent retreat and decline are coeval with the rapid increase of Dungeness to the leeward. In effect, Langley Point in 1736 projected three-quarters of a mile further into the sea than at present, and it is a curious fact that the breakwater proposed by the Harbour of Refuge Commission of 1840, parallel to, and one mile from the shore in Eastbourne Bay, opposite the "Wish Tower" site and the Grand Redoubt touched at the north-east end of its eastern *kant* the low-water line of 1736, as shown by the surveys of Desmaretz, the well-known ordnance surveyor of that period, but situate in three to four fathoms of water in 1840. This is a striking illustration of the amount of speculation respecting any increased area of anchorage to be obtained and maintained by artificial works in the vicinity of these shingle moles or inclosing recessions therein. In Desmaretz's time the bays west and east of this formation, viz. Eastbourne and Pevensey bays, like those now at Dungeness, must have afforded considerable shelter with three fathoms of water, now, however, reduced to one, and the area of shelter correspondingly curtailed.

Dummer's plan of 1698 shows that then the haven was open up to the castle, with the site of an old outfall about one mile west of the then entrance, which had been deflected eastward by the travelling shingle, and about this period, from its becoming constantly blocked up, the land-owners appear to have taken steps to render the drainage permanent by placing a sluice and trunk at the entrance, so that the haven has lapsed into a marsh sewer or drain.

A reference to well-known maps shows that this Ness must have advanced seaward up to a certain period, at the rate of ten yards per annum, when, however, the western supply became greatly diminished by the old Brighton beach being gradually used up, the subsequent diminution and retreat of this point afforded material for the continued increase of Dungeness to the leeward of it.

From 1724, downwards, the recession of the point has averaged over certain terms a rate of from seven to ten yards per annum, entailing the abandonment of several of the Martello Towers which fringe this portion of the coast, as well as the west fort at the Point, dismantled forty years back, also constant expenditure in heavier and deeper retaining walls in front of the fosse of the circular redoubt, at its western extremity, to check the repeated local encroachment of the sea.

It results from this continued recession of the shore that the works at the circular redoubt form an advanced point. In the early part of this century the shore in front of this work was much more seaward, and in front of particular Martello Towers in Eastbourne Bay it has retreated over certain terms of years at the rate of one yard per annum. This is shown by the known distance from the towers to high-water mark at the time of their construction. The waste since the erection of these towers has been mainly westward in Eastbourne Bay, accompanied by a certain local increase for a short distance to the eastward of the Point in Pevensey Bay, a similar result to that experienced at Dungeness.

From Dungeness to Langley Point, a stretch of thirty miles, except where intersected by harbour mouths, there is an uninterrupted belt of shingle. Over the last century an elongation of the east point (Dungeness) appears to have consumed the western surplus supply, as shown by the corresponding retreat of the western (Langley) point. The intermediate belt has with less fluctuation been driven more landward, showing that a littoral wasting away from wave action at one point is balanced by a corresponding increase at another.

The plan by Grenville Collins, 1693, shows Pemsey Haven clearly defined with two arms or branches, and a considerable entrance, but contains no notice of such a projection as Langley Point. The topographical survey by Yeakel and Gardner, 1778, a well-executed map to a scale of two inches to the mile, shows it stretching one and a quarter mile into the sea in a south-easterly direction. Of course the accuracy of the rates of progression and retrocession given above are based on a comparison of Desmaretz's surveys with those of recent date, and depend on the character of the former. The remarkable changes in the coast-line along Eastbourne Bay, its small depth, the little protection afforded by Beachy Head, and the eastward movement of Langley Point, are, as in the Dungeness case, arguments against artificial works in either of these bays.

J. B. REDMAN

6, Queen Anne's Gate, Westminster, S.W., April 29

Colour Perception

MR. HANNAY'S explanation of the colours observed in his dark rooms, seems quite in accordance with orthodox science. It is not the explanation I should myself offer, but as that would occupy too much space, and as I am conscious I should not carry the public with me, I refrain from entering on it.

What I do object to is the notion apparently entertained by Mr. Hannay, that his attempted explanation of this single phenomenon, explains also the experiments in the formation of colour I showed him. How can this explain the fact that I can show in the space of a few inches, from mixture of black and white alone, a dozen different colours side by side, mostly as clear and bright as if painted? And how does it explain the fact, that using the exact same proportion of black and white, and working at the same speed, the motion to the one hand will produce *red*, and when reversed, *blue?* Mr. Hannay also seems to imply that the colours of my experiments to be seen well, should be looked at passively or without keen attention. On the contrary, the more light thrown on them, and the keener, fresher, and younger the eyes of the observer, the more brilliant are the colours, and if a boy of ten or twelve years old, who never saw anything of the sort before, be called in, he will describe them better than grown people.

Scientific men have hitherto considered it a sufficient explanation of these experiments to say the effects are "physiological," as if colour were ever anything else. Newton says, speaking of *coloured rays*, that he uses the term merely to suit the understanding of the vulgar, as they are nothing but a certain power and disposition to stir up a sensation of this or that colour. Prof. Ogden Rood again classes these as *subjective* colours, a word which, if it has any meaning at all beyond a very limited one, can have none with reference to colours which remain permanent so long as the machine is in motion.

27, York Place, Manchester, April 22 NAPIER SMITH

How may Clouds consisting of Liquid or of Frozen Water be Distinguished?

IN NATURE, vol. xxv. p. 529, M. de Fonvielle asks my opinion as to what observations may be made in a balloon to discover whether in a cloud whose temperature is below zero the minute particles of water are liquid or solid.

There may be difficulties in the way of deciding by direct observation of the form of the particles, whether they are globules or crystals. But since H. B. de Saussure, a century ago ("Essai sur l'Hygrométrie), by means of a single lens, could distinguish in the air over heated water, globules of condensed water of different size, greater ones which appeared to him full, and smaller ones which he regarded as hollow; and when in more recent times A. Waller (*Philosoph. Transactions*, 1847) could make his "microscopic observations on the so-called vesicular vapour of water as existing in the vapours of steam and in clouds, &c.," with the result that he denied the existence of mist-vesicles, it seems possible that by means of a magnifying instrument the form of the particles suspended in the air can be recognised.

A sure evidence, but obtainable only under favourable circumstances, that the particles forming a cloud are ice-crystals would be the observation of the halos of 22° and 46° radius and of parahelions as produced by the cloud. HERMANN KOPP

Heidelberg, May 3

On the Conservation of Solar Energy

Dr. SIEMENS's theory of the constitution of the sun implies that there is an absorption of solar rays constantly going on in space. If this is so, space cannot be perfectly transparent.

An astronomer of the early part of the present century—I think it was Olbers—came to the same conclusion, though from different reasons. He found that as the space-penetrating powers of the telescope is increased, the number of stars that become visible does not increase so rapidly as it would if they were evenly scattered through space, and if space were perfectly transparent; and he concluded that most probably space is not perfectly transparent. This, however, is by no means conclusive, because it is possible that the reason why the number of stars that become visible does not increase as it ought to do on the supposition, is that the number of stars in the universe is limited.

JOSEPH JOHN MURPHY

Old Forge Dunmurry, co. Antrim, May 3

CYCLONES[1]

II.

IN our former article we dwelt on the deductions arrived at by the author from a consideration of the mechanical theory of cyclones. We will now proceed to examine how far such theoretical relations are corroborated by the results of observation. The results of observation utilised by the author comprise those of the Rev. W. Clement Ley, published in his "Laws of the Winds"; those of Prof. Loomis, deduced from a study of the U.S. Signal Service charts; those of Dr. Hildebrandsson, with regard to the upper currents from an examination of the Danish synoptic charts; those of Capt. Toynbee, from a study of the Atlantic storms; and lastly, some contained in a recent work on the hurricanes of the Antilles, by Padre Viñes of Habana. Mr. Ferrel at the outset pointedly remarks that for a mariner to be able to make use of the laws deduced from a study of the theory of cyclones, not only a knowledge of such laws is requisite, "but likewise of the *normal* states of the wind and of the barometric pressure in all parts of the ocean and at all seasons of the year, unaffected by the abnormal disturbances of these progressive cyclones; since with a knowledge of the normal conditions of the winds and of the barometric pressure at any time and place he can perceive the first indications of the abnormal disturbances which are the forerunners of these storms, and so can be on his guard, and then with a knowledge of these storms or cyclones, he can generally avoid at least their most dangerous part."

With regard to the first result from theory, viz. the general incurvature of the winds in a cyclone, which was formerly altogether denied by the cyclonists—so-called—Reid and Piddington (not Redfield), or inordinately magnified in every case by Espy, and other upholders of the radial theory, there seems to be no doubt from the results of observation here given, as well as from others not cited by the author, that the wind deviates to a considerable extent from the tangent to the isobars inwards towards the low centre. Moreover, in accordance with theory, this inclination is greater at inland stations where there is more surface friction than at or near the sea when it is less. Thus Ley found the inclination to be about 29° for inland stations, but only 13° for those on the coast. This difference between the inclination at sea and on land may perhaps account for the tenacity with which sea captains still cling to the notion that the wind blows in circles coincident with the isobars; since it is precisely at sea where the incurvature should theoretically be least. The increase in the inclination corresponding to a decrease in the latitude is likewise borne out by observation. Thus from Ley's observations, which embrace North and South Europe, the mean inclination to the isobar is about 25°, from those of Capt. Toynbee on latitude 50° it is 29°, from those of Loomis nearer the equator in America 47°,[1] from those of Padre Viñes in the Antilles 45°, and we may add from some in the Bay of Bengal, mentioned by Blanford, about 42°.

It is thus pretty evident, as the author remarks, that "though the horn-cards of Piddington based on the strictly circular theory of the winds may still be used at sea in high latitudes without great error, yet nearer the equator they must become more erroneous, and entirely fail at the equator if cyclones could exist there." Mr. Meldrum, of Mauritius, as far back as 1867 drew attention to the disasters which resulted in consequence of vessels having estimated the direction of the centres of cyclones according to the rules of the circular theory, and since the publication by M. Faye of his "Défense de la loi de tempêtes," has strenuously opposed the resuscitation of this exploded doctrine. He has also lately given an admirable proof of the truth of the incurvature, by publicly announcing when the wind, in a cyclone on March 21, 1878, was from the north-east in Mauritius, that the centre of the storm was not to the north-westward according to the circular theory, but to the west-south-westward, which was afterwards found to have been the case.

It is a manifest duty therefore which mankind owes itself, if the dangers of the sea are to be minimised, that the amount of inclination of the wind to the isobar should be determined by observation in different seas and for

---

[1] "Methods and Results of Meteorological Researches for the use of the Coast Pilot." Part II.—On Cyclones, Waterspouts, and Tornadoes. By William Ferrel. (Washington, 1880.) Continued from p. 12.

[1] Some of these included very gentle winds.

different latitudes, in order that the navigator may be able to modify his rules accordingly, and so avoid such a fatal error as that of running gradually into the centre of a storm, which a rigid adherence to Piddington's rules would be certain to entail.

So far we have not considered what effect is produced on the inclination by the progressive motion of a cyclone. Were a cyclone regular in form and stationary, the inclination should obviously be the same at every point on the surrounding isobars. When, as is generally the case, it has a progressive motion, this—on the supposition that it is mainly due to the general motions of the atmosphere—should, by a simple application of the parallelogram of velocities, alter not only the velocity but the direction of the inflowing winds, increasing their inclination in the rear, and diminishing it in the front part of the cyclone.

This conclusion tallies remarkably well with the observations of Padre Viñes in the Antilles, where the cyclones travel westwards, as well as with those of Prof. Loomis in North America, where they travel towards the east. When we come to Europe, however, a remarkable exception to this rule occurs, since here the inclination is much *greater* on the east or front side (especially south-east) of a cyclone than on the west or rear side.[1] The author attempts an explanation of this fact on p. 40, but a better one both of this and of the equally enormous though opposite difference found by Loomis between the inclination in the rear and front parts of cyclones in the United States, which can hardly be altogether due to the admittedly small velocity of the general motion of the air over America from west to east is given by Lieut. Spindler, of the Russian Navy, in a recent number of the *Repertorium*,[2] where he considers it to be mostly due to the friction encountered by the wind on the Continental side of cyclones, increasing the inclination in the west and therefore rear part of the American cyclones, and that in the east or front part of the European cyclones.

If the general truth of the difference between the inclination in the front and rear of cyclones at sea, due to their progressive motion, be admitted, the case of the poor navigator becomes still more complicated, as in addition to considering latitude, distance from the centre, and velocity of the wind, he must likewise consider in what quadrant of the cyclone he is situated, since the direction of the vortex with reference to that of the wind, is so different in different quadrants. Fortunately it is just in front of a cyclone—the most dangerous position for a ship to be in—where the old circular rules are least at fault, since it is precisely here where theoretically the inclination should be least.

With respect to upper currents, the results derived from theory are remarkably confirmed by those from observation. In general, since the air flows in towards the centre below, it must flow out from it above, and also somewhat across the current which flows below, so that if we stand facing the wind at the earth's surface, and at no very great distance from the low centre, the upper current should almost invariably flow from some point to our right. This agrees with observation, since, according to Clement Ley, the average direction of the upper currents is 44° to the right of the direction from which the surface-winds blow. The general conclusion arrived at by Mr. Ley regarding upper currents, that they "manifest a centrifugal tendency over areas of low pressure, and a centripetal over those of high," is identical with that arrived at by Dr. Hildebrandsson, and with the author's theory as far as it applies to ordinary, or as he calls them, warm-centred cyclones.

Cold-centred cyclones, to which we alluded in our previous article, do not seem to have been identified by the author except in a stationary form surrounding either pole. The observations of the upper currents hitherto made indeed argue powerfully against their existence at all in the progressive form, since in their case the upper currents should flow in towards the low centre, accompanied by a gentle outflow below, a state of things diametrically opposed to all present experience in connection with a central area of low barometer.

The author next discusses the effect of the general progressive motion of the atmosphere on the upper currents, which is similar to that on the lower currents, but larger in consequence of its increase with the altitude.[1] In winter when the progressive motion is theoretically larger than in summer (Part I.), the upper currents in our region should in nearly all cases move from some westerly point, acquiring their greatest velocity on the south side of the low centre. In summer the directions should be more variable, and the wind's velocity less. Observation verifies both these conclusions; thus Clement Ley found the greatest velocities of the upper currents, such as 120 miles an hour, to occur generally in the winter, when the cyclone centre was to the north or north-east, and it was travelling eastwards. On the other hand the cases in which the upper clouds were found to be stationary most commonly occurred in summer, and near the centre of areas of high pressure. These facts, both as regards the strength and direction of the upper currents, are confirmed by Prof. Loomis's observations of the winds on Mount Washington. The author then proceeds to show how the upper currents may be employed to indicate through the medium of their visible accompaniments—the cirrus clouds—the approach and direction of a distant cyclone; a point most valuable to the seaman, who cannot command a daily weather chart. He says: "The almost universal precursor of a distant storm is the appearance of more cirrus-clouds than usual, not only differing from those of the general currents in form, but also in the *direction* of the currents indicated by those clouds."

In low latitudes, where according to theory the upper and lower currents are more nearly radial to and from the centre respectively, the direction from which these clouds come, especially while the storm is still at some considerable distance, is found to indicate very nearly the direction of its vortex. In higher latitudes matters are more complicated, since the currents are more tangential, the upper currents flowing anticyclonically at great distances from the centre, but even here, the observer will not, as a rule, be far wrong according to the author's diagrams, and those of Clement Ley, if he places the centre of the approaching storm a little to the right of the direction from which the cirrus advances.

Regarding the existence of an anti-cyclone in connection with every cyclone, and the broad annulus of high barometer with its maximum at the dividing limit between them, the author finds ample confirmatory evidence; though from the fact that the depression at the centre is more marked than the rise of pressure near the border of the cyclone, the latter is often so masked by other irregularities as not to be readily discernible on a synoptic chart. In our own islands, where we frequently encounter a string of small cyclones travelling over us from the Atlantic, the barometer rises briskly after the passage of each low centre only to warn us of the approach of its successor, from whence no doubt arose the old maxim, "Quick rise after low foretells stronger blow." The author mentions that the approach of the hurricane of September, 1875, was indicated at Havana by a sudden rise of the barometer,

---

[1] In the north-west quadrant the inclination according to Ley is only 9°, while in the south-east quadrant it is 35°.

[2] Ueber die Abhängigkeit der Stärke und Richtung des Windes von der Grösse und Richtung des Gradienten an den Küsten des Baltischen Meeres. "Rep. für Met., tom. vii. No 5. St. Petersburg, 1880.

[1] This increase in the velocity of the general atmospheric drift with the altitude is shown in Part I. p. 45, to result from the relations between the velocity of the wind and the observed barometric pressures and temperatures in different parts of the world. For the latitude of the British Isles the eastward component of velocity at the elevation of five miles—the height of the cirrus-clouds—is estimated to average about sixty-three miles per hour in January, twenty-nine miles per hour in July, and throughout the year about fifty miles per hour. At the surface, the mean velocity is calculated to be four miles per hour in January, and two and a half miles in July.

while the cyclone was yet at the Windward Islands, about 1200 miles distant.

A sudden and abnormal rise of the barometer thus constitutes as important a warning to a navigator as a similar fall, or a band of cirrus-cloud, only to be able to make effective use of this danger-signal he ought accurately to know the normal height of the barometer where he is, and at the time of year. The author shows how this may be done in Part I., where he has constructed charts, based on a large series of observations in the northern hemisphere, showing not only the curves of mean annual pressure, but also those which represent the coefficient of annual inequality. From a simple equation involving these two elements, the normal pressure at any time and place can be approximately reckoned, and hence the amount of abnormality determined.

The author next applies the cyclone theory in explanation of the various inequalities of barometric pressure, which are observed on the same latitude in different longitudes. These inequalities he considers to be mainly dependent on the deviations of the mean temperature (annual or monthly) from the mean of all longitudes, which he gives in a tabular form for every fifth degree of latitude and every tenth degree of longitude in the northern hemisphere, by means of interpolation from the observations discussed in Part I. From these tables it appears that in addition to, and superimposed upon, the general system of two polar cyclones due to the normal differences of temperature between the Equator and the Poles, we have throughout the year, and more especially in the winter, the conditions for the existence of a large fixed warm-centred cyclone in the North Atlantic, with its centre near Iceland. The barometric pressure should consequently be lower here than the mean of the latitude taken round the globe. That this is the case is well-known, and also that the prevalence of south-west winds in these islands is due to our generally lying on the south-east edge of this nearly perpetual cyclone. A similar cyclone similarly produced lies in the North Pacific.

Two corresponding regions of abnormally low temperature lie one on the east side of Asia, and the other on the east side of America, which, according to the author's theory, should give rise to cyclones with cold centres. As a matter of fact, however, these conditions are found to be completely reversed; the pressure being above the average, especially in winter, when the temperature-gradients are steeper, and therefore, according to the author's views, the cyclonic conditions should be more developed; while the motion of the air at the surface is anticyclonic, and outwards from the region of greatest relative cold.

The least satisfactory part of the author's work is that which relates to these cyclones with cold centres. Their non-existence in the progressive form is admitted, and where they should occur according to theory in a stationary form, they are notably absent, except in the two circumpolar cyclones. It is possible, however, that they may be identified, though in a modified form, and lacking the central barometric depression *at the earth's surface*, with what are termed "winter anticyclones," which usually coincide with areas of great cold, and which, while they exhibit at the earth's surface an anticyclonic outflow of air, are fed above a certain level by a cyclonic inflow.

Finally, as regards rainfall, which is an almost unfailing accompaniment of cyclones, the author, while admitting its assistance in helping to maintain a cyclone when once started, by the forces which operate whenever vapour is condensed, is strongly opposed to its being a *primary* source of energy, and cites in favour of this notion the following conclusion, arrived at by Prof. Loomis, after a careful study of the U.S. Signal Service charts. "Rainfall is not essential to the formation of areas of low barometer, and is not the principal cause of their formation or of their progressive motion."

The last chapter of the author's work which relates to tornadoes, waterspouts, and hailstorms, has already been referred to in a special article in NATURE, and it only remains for us to observe in connection therewith, that while tornadoes differ specifically in many respects from cyclones, the condition of the atmosphere in the latter is eminently favourable to their production. To this circumstance, according to Ferrel, may be attributed the occurrence of sudden blasts of tornado violence in the middle of cyclones, accompanied by a rapid oscillation of the wind-vane. It is these sudden gusts which do the main damage in such cases, since, as might be expected, the velocity of the wind increases *per saltum* where the gyrations of the tornado and the cyclone coincide in direction. They are found to occur more on the cold or clearing-up side of a cyclone, which Ferrel explains to be due to the cold upper strata overlapping the warmer central part of the storm, and thus promoting a condition of vertical instability of equilibrium in which tornadoes are generated with facility. Viewing the work as a whole, Mr. Ferrel may be congratulated on having presented to the world a memoir of such luminous research as well as practical utility. When we compare it with the numerous other crude treatises and hypotheses evolved during the past half-century on the same subject, which have not only brought the science of meteorology into ridicule, but encumbered our libraries, we feel a deep sense of relief at finding the question dealt with by a mathematician of more than ordinary ability, and one who does not shrink from tackling the real difficulties of the subject. He has for some time been known by his writings on hydrodynamical questions of great importance, especially those applying to the general motions of the atmosphere. The present work will go far towards placing him in the very front rank of physical and theoretical meteorologists. The deductive method has been fairly applied throughout to the equations of motion, and its success will do much towards counteracting the too prevalent tendency at the present time to induct from every solitary phenomenon, or experiment, to some otherwise baseless hypothesis. If the author has not accounted for all the peculiarities of cyclones, he has at least shown that the views entertained by the leading meteorologists regarding their formation, characteristics, and general movements accord with their mechanical theory, and that the sources of energy ordinarily assumed to act, such as heat, gravitation, and terrestrial rotation, are sufficient, without having recourse to any wild hypothesis founded on some unknown function of electricity. The valuable practical hints and suggested modifications of existing rules will do much to avert disasters at sea, the main purpose, doubtless, for which the work was designed, while its thoroughness and comprehensive character will materially help to advance our knowledge of a meteor, which in one form or another comprises almost every condition of the atmosphere included under the term "weather."

E. DOUGLAS ARCHIBALD

ON PHOTOGRAPHS OF THE SPECTRA OF THE NEBULA IN ORION[1]

FOR about eighteen months I have been giving attention to the nebula in Orion with two objects in view, first to ascertain whether any changes are taking place in that body by making a series of photographs to be compared in the future with a similar series; and second, to photograph the spectrum of the nebula in various parts so as to see whether any new lines could be found, and also whether the composition is uniform throughout.

As to the first of these objects I have recently suc-

[1] Read before the National Academy of Sciences, April, 1882, at Washington, U.S., by Henry Draper, M.D. Communicated by the author.

ceeded in taking a very fine and extensive photograph of the nebula containing most of the delicate outlying parts which were not in my earlier photographs. This is in the hands of the photolithographer now and will shortly be published. The experiments have been very difficult because an exposure of more than two hours in the telescope has been necessary, and an exceedingly minute motion of the stars relative to the sensitive plate will become apparent on account of the high magnifying power (180) employed.

In carrying out the second object two contrivances have been used; first, a direct-vision prism in the cone of rays from the objective before they had reached a focus, and second the two-prism spectroscope with which I have taken photographs of stellar spectra for some years past.

During the month of March I have made two good photographs with each of these arrangements. Those with the direct-vision prism, without a slit, have of course demanded that the image should be kept stationary on the sensitive plate throughout the exposure, viz. two hours, and they are as difficult to get as good photographs of the nebula itself. On the contrary, those obtained with the slit spectroscope do not require the same steadfast attention.

The results derived from these photographs are interesting partly from what they show and partly from what they promise in the future. A number of photographs, under various conditions, will be needed for the full elucidation of the subject.

The most striking feature is perhaps the discovery of two condensed portions of the nebula just preceding the trapezium, which give a continuous spectrum. At those places there is either gas under great pressure or liquid or solid. I have not been able to detect any stars of sufficient magnitude in these portions to produce this effect either in my photographs of the nebula or in any of the well-known drawings of this object. It seems to me also that the photographs show evidence of continuous spectrum in other parts of the nebula. In these respects the conclusions arrived at by Lord Rosse in his memoir (*Phil Trans.* Royal Society, June 20, 1867, p. 70) are to a certain extent borne out.

The hydrogen line near G, wave-length 4340, is strong and sharply defined; that at *h*, wave-length 4101, is more delicate, and there are faint traces of other lines in the violet. Among these lines there is one point of difference, especially well shown in a photograph where the slit was placed in a north and south direction across the trapezium; the Hγ line, λ 4340, is of the same length as the slit, and where it intersects the spectrum of the trapezium stars, a duplication of effect is visible. If this is not due to flickering motion in the atmosphere, it would indicate that hydrogen gas was present even between the eye and the trapezium. I think the same is true of the Hδ line, λ 4101. But in the case of two other faint lines in this vicinity, I think the lines are not of the length of the slit, one being quite short and the other discontinuous. If this observation should be confirmed by future photographs of greater strength, it might point to a non-homogeneous constitution of the nebula, though differences of intrinsic brightness would require to be eliminated.

The April number of the *American Journal of Science* contains an account of a photograph of the spectrum of this nebula taken by Dr. Huggins. I have not found the line at λ 3730, of which he speaks, though I have other lines which he does not appear to have photographed. This may be due to the fact that he had placed his slit on a different region of the nebula, or to his employment of a reflector and Iceland spar prism, or to the use of a different sensitive preparation. Nevertheless, my reference spectrum extends beyond the region in question.

As illustraring the delicacy of working required in this research, it may be mentioned that in one of these photographs the spectrum of a star of the tenth magnitude is easily discerned. It is only a short time since it was considered a feat to get the image of a ninth magnitude star, and now the light of a star of one magnitude less may be photographed, even when dispersed into a spectrum.

EPPING FOREST

ON Saturday last, May 6, the Queen declared free to the public the 5600 acres of open land to the north-east of London, known as Epping Forest. The history of the rescue of this magnificent tract, so long the favourite resort of London naturalists, has been told many times since the Corporation of London took up the question, and by their well-directed efforts not only checked the encroachment of rapacious land-owners, but restored to the people about 1000 acres of forest land that had been illegally inclosed. The total cost of this philanthropic movement may be estimated at nearly half a million of money, and the Corporation has deservedly earned the gratitude of all Londoners, and more especially of those lovers of nature who have for long been in the habit of regarding the Forest as a preserve from which they could obtain materials for their studies. It is a common complaint with our natural history students, that the open spaces around London are gradually being destroyed as the pressure of population necessitates increase of buildings in the suburbs, so that the preservation of this large area is really a matter of considerable scientific importance, and as such will be regarded with satisfaction by the readers of NATURE. Fortunately for naturalists, the Act of Parliament declares that the woodland tract under consideration shall be kept as far as possible "in its natural aspect." There has thus been secured to the public at large, and to the metropolitan field naturalists, a recreation-ground of a quite peculiar character, and one which will be looked upon as a great boon by botanists, zoologists, and microscopists.

The value of Epping Forest, from our point of view, lies chiefly in its wildness; by far the greater portion is primitive woodland, which has been but little interfered with by man in comparison with the heaths and commons to the north, west, and south of London. Such an expanse requires little in the way of "improvement." The Conservators have acquired a power of dealing with one of the few surviving remnants of primæval Britain, and in the interests of that continually increasing class of the public who devote themselves to the various branches of out-door natural history, it is to be hoped that this authority will be exerted judiciously. We are disposed to believe that the requirements of the ordinary holiday-maker and of the field naturalist are in this case identical. To be able to roam through many miles of wild forest is as truly a pleasure and novelty to the former as it is a necessity to the latter. From whichever side we view the question of the conservation of the forest, any attempts to destroy its natural features cannot but be deprecated, and in view of the fate of so many of the open spaces round London, this position cannot be too strongly emphasised by those to whom the preservation of our rapidly-disappearing natural history resorts is a matter of importance.

The problem of managing a tract of country which consists of a large proportion of primitive forest and a smaller proportion of land formerly under cultivation, so as to comply with the conditions of the Act and with the requirements of all classes of the public, is not so difficult as might appear at first sight. It is not as though the interests of field-naturalists in any way clashed with those of the general public. We have here a wide expanse *pro delectatione populi*, which is to be distinguished and to be kept distinct from all other public spaces in the vicinity of the metropolis by virtue of its forestal wildness, and in order to maintain it in its "natural" condition it would have been better if the Conservators had taken counsel with some of the numerous scientific societies of London which are representative of the various classes of natural history students and investigators. This is indeed the only point—but it is a serious one—on which we feel compelled to express our disappointment at the line of management taken up by the Conservators. The Epping Forest Committee consists of twelve members of the Corporation and four Verderers chosen septennially by the commoners of the Forest parishes. Now a Committee appointed to deal with a scientific question—and as such we regard the management of a forest—cannot altogether ignore the claims of natural history without incurring the risk of having their proceedings compared with the tragedy of Hamlet with the Prince of Denmark left out. The present Verderers are Sir T. Fowell Buxton, Mr. E. N. Buxton, the Chairman of the London School Board, Mr. Andrew Johnston, late High Sheriff of Essex, and Mr. D. J. Morgan. The names of these gentlemen encourage us to think that it is no fault of theirs if the claims of natural history science are altogether ignored.

How to deal with those waste stretches of land formerly under cultivation is a question quite distinct from the management of the wooded portions of the forest. While for the latter a minimum of interference would in our opinion be most in accordance with the views of all parties, there are ample opportunities of "landscape gardening" the former. In face of this fact it is somewhat surprising that the energies of the Conservators should thus far have been chiefly directed to alterations in the *natural* portions of the area under their charge, and we are glad to see that the Essex Naturalist's Field Club has taken the initiative in inviting the co-operation of all natural history students interested in the preservation of open spaces in their natural condition, in signing a protest against the destruction of the natural features of Epping Forest. The form of petition has been forwarded to all the scientific societies of London most concerned in this question, and has already received many influential signatures. If the dedication ceremony of last Saturday makes the freeing of the Forest an event in the history of this country, it seems but just that in a period pre-eminently distinguished for its scientific culture, the naturalists of London should urge their claims ere it be too late. R. M.

THE WINTER OF 1881-2

THE fine winter months of 1881-2, from November to March, have been characterised by a mildness rarely equalled in our British climate. Nowhere in the British Islands, from Scilly to Shetland, or from Dover to Valentia, was the mean excess above the normals of the temperature of these five months less than 2°·0. This was the excess in the south of England; in central districts, such as Oxford and York, it rose to 3°·0; and the excess increased on advancing northward till it reached 4°·0 in the upper districts of the Tweed, Clyde, Tay, and Dee, and at Culloden, and Lairg. Everywhere on the coasts the temperature was from half a degree to a degree, relatively lower than in strictly inland situations.

In Scotland the mean temperature of each of the months exceeded its normal, except in a very few localities in December, when temperature was slightly under the average. Each of the other months had a temperature from 2°·5 to 6°·0 above the normal. In England, on the other hand, the temperature of January was pretty generally under the average, the deficiency amounting in some cases, as at Spurnhead, to nearly 2°·0; and in the central districts of Ireland the deficiency was even greater. In February, in a few districts of England, temperature fell slightly below the normal, whereas, over large districts of Scotland, in the same month, it rose to at least 5°·0 above the normal.

As regards atmospheric pressure, its geographical distribution during these months was strikingly abnormal. In each month, as regards departures from the normals, there was an excess in the south, whereas in the north there was a deficiency, or if there was an excess at all, it was much less than in the south. The averages of the five months give an excess above the normal of 0·188 inch at Torquay, and 0·171 inch at Greenwich; 0·116 inch at Llandudno; 0·063 inch at Lissan, Tyrone, and 0·088 inch at Silloth; 0·023 inch at Islay, and 0·061 inch in East Lothian; 0·011 inch at Monach, Outer Hebrides, and 0·045 inch at Aberdeen; but a deficiency from the normal of 0·019 inch at Kirkwall, 0·048 inch at North Unst, and 0·103 inch in Farö. It was to this unprecedentedly steep barometric gradient from south-east to north-west from the normals of these winter months, and the equally unprecedented predominance and force of south-westerly winds which resulted therefrom, that we owe the remarkable mildness of last winter. The extraordinarily high pressures which so frequently ruled on the Continent during the winter, and the all but rainless weather which accompanied these anti-cyclones, and the low state of many of the rivers on the one hand, and on the other the almost unbroken succession of storms which swept the Atlantic with their low pressures and destructive tempests of wind, may be pointed to as the outstanding features of the great atmospheric disturbance which has signalised the winter of 1881-82, of which the mildness of the weather in the British islands was merely an accompaniment.

If the winters of the north-east of Scotland, from which there are temperature observations since 1764, be examined, it is seen that the mean temperature of the five months from November to March have been 2°·0, or more, above the normal during eighteen winters. These winters, with the amounts of the excess above the normal, are given in the following table, to which is added the excess or deficiency from the normals of each of the six summer months immediately following:—

Winters.	Excess above the normal.	April.	May.	June.	July.	Aug.	Sept.	Mean of six months.
1772-73	+2°·0	+1°·2	-1°·4	-0°·7	-1°·5	+1°·4	-1°·2	-0°·4
1777-78	+2·0	-0·2	+3·8	+4·4	+3·6	+1·8	-1·2	+2·0
1778-79	+5·2	+2·9	+1·7	+3·4	+7·4	+6·8	+3·5	+4·3
1780-81	+2·0	+3·5	+2 6	+5·1	+1·4	+0·0	-1·1	+1·9
1789-90	+4·2	-2 0	+1·2	-1·2	-3·3	0·2	-3·3	-1·5
1793-94	+3·6	+4·2	-0·7	+2·6	+3·6	8	+0·5	+1 6
1795-96	+2·3	+7·9	-0·9	-1·3	-3·5	+0·5	-0·2	+0·4
1827-28	+2·7	+0·6	+1·5	+1·8	-0·5	0·2	+1·7	+0·8
1831-32	+2·5	+1·2	-1·0	+0·8	-0·4	+0·2	+1·3	+0·4
1833-34	+3·2	+0·5	+2·6	+1·8	+1.2	+1·2	+1·2	+1·4
1834-35	+2·4	+0·0	-0·7	-0·8	-0·5	+1·9	-0·6	-0·1
1843-44	+3·8	+5·1	-0·9	-0·0	-1·2	1·6	+0·4	+0·3
1845-46	+4·1	+0·1	+3·5	+6·5	+1·3	+2·7	+6·5	+3·4
1848-49	+2·3	-1·9	+1·3	-2·2	-1·3	0·2	-0·4	-0·8
1850-51	+2·1	-1·4	+0·2	-0·9	-1·3	0·7	-0·4	-0·7
1857-58	+2·8	+0·1	-0·3	+4·4	-2·8	+1·2	+0 8	+0·6
1868-69	+2·2	+2·5	-4·5	-2·0	+1·7	0 9	+0·5	-0·5
1881-82	+4·1							
Means ...	+3·0	+1·4	+0·5	+1·3	+0·2	+0 8	+0·5	+0 8

Thus, so far as the north-east of Scotland is concerned, the mildness of the winter of 1881-82 has only been twice exceeded, viz. in 1789-90, when it was 4°·2, or 0°·1 more, and in 1778-79, when it was 5°·2, or 1°·1 more. The winter of 1845-46 showed the same excess as last winter.

We also gather from the table that these winters, which gave a mean excess of 3°·0, were immediately followed by summers warmer than usual, the mean six months' excess being about a degree (0°·8). Indeed, of the whole seventeen summers, only one, viz. the summer of 1790, can be considered as showing a deficiency of temperature sufficiently great and prolonged to be regarded as attended with serious consequences to agriculture. The table is a striking general confirmation of the prognostic long and widely entertained that a mild winter is the precursor of a fine warm summer.

SEVRES PORCELAIN AND SCIENCE

THAT the French should know better than any other nation how to enlist art in the service of science is just what might be expected. Such a service on the part of art to science is only a fair return for the immense resources which scientific research has been able to place at the disposal of art. Nowhere have the discoveries of science been more useful or more utilised than at the celebrated porcelain manufactory of Sèvres, and the illustrations which we give to day will afford some idea of the beautiful results which are thus produced. As a permanent record of successful scientific efforts, nothing could be more satisfactory and appropriate. In Fig. 1 the characteristic features of the Arctic regions are rendered with almost perfect success and truthfulness; while the allegorical representation in Fig. 2, in commemoration of the last transit of Venus, is happy in conception, and charming in effect. Of the artistic merits of the two vases our readers can judge for themselves. It may be interesting to give some idea of the difficulties attending the manufacture of such delicate productions, which we are able to do, from a lecture by M. Ch. Lauth, Administrator of the Sèvres manufactory, published in *La Nature*, to which journal also we are indebted for our illustrations.

Fig. 1 represents a vase which has been presented to King Oscar of Sweden, and is one-eighth of the original size. The splendid vase represented in Fig. 2 is still only in course of execution, and when complete will be placed in the Mazarin Gallery of the French National Library; it will be ten times the size of the illustration. M. Lauth thinks the national institution at Sèvres should be organised more as a school for the training of workers in the delicate art, than as a mere manufactory. The art of fixing colours on pottery, M. Lauth tells us, differs essentially from that which deals with the colouring of any other medium. There is required in the materials perfect adhesion, absolute resistance to atmospheric influences, and a brilliancy which will make the colours seem part of the object itself. As the colours must be subjected to a very high temperature, there must be eliminated from the palette of the ceramic artist all organic colouring matter, and all the unstable mineral colours; he must have recourse to oxides, metallic silicates, or to metals. And the fixation of these colours is always the result of a chemical action, of a combination which takes place at a high temperature between the body of the porcelain and the matters used in its decoration. Many different methods are used for the purpose, but they are divided into two great classes—decoration at great heat, and the decoration by muffle, an oven of a special kind.

The former consists in applying to the porcelain, colouring substances, which are fixed and developed at the same temperature as that at which the porcelain is baked; this is how the most valued results are attained; as the enamel covers the colour, it assumes an extreme brilliancy and depth—it becomes part and parcel of the object itself. This is how the magnificent blue of Sèvres is obtained, as well as certain browns and blacks, and a few other combinations. The colours may be either mixed on the paste, or put upon the object when moulded, before enamelling, or mixed on the object itself when complete; they may be also applied to porcelain already baked, which may be again baked at the higher temperature. This is notably the process employed at Sèvres for their blues. One of the most brilliant varieties of decoration at high temperature consists in what is called the process of *pâtes d'application*. This method consists in painting by the brush on porcelain unbaked or heated; by successive and carefully adjusted applications, a very great thickness is attained, by sculpturing which the artist can give the decoration a re-

FIG. 1.—Sèvres Vase, commemorative of the North-East Voyage of Baron Nordenskjöld (1/8).

Fig. 2.—Vase, commemorative of the Transit of Venus in 1874, by M. Joseph Chéret ($\frac{1}{13}$).

markable finish and value. The object is then heated, enamelled, and baked.

It is different with the decoration accomplished by means of a muffle oven; in this method the painting is always made on baked porcelain, and consequently on enamel, and the heat employed is relatively low. In this process there is necessary, in order to make the colours on the metals adhere, a medium, which is called the *fondant;* it is generally a silicate, or silico-borate of lead. By raising the temperature, these bodies are fused, attack the object, combine with it, and at the same time determine by that reaction the adhesion of the colour. According to the nature of the *fondants* and colours, a greater or less heat may be applied; and as certain colours are more sensitive than others, it is frequently necessary to bake at successive fires of different temperatures. The baking of colours by this process requires very great experience; the absence of any instruments of precision is greatly felt, and there is no other means of ascertaining the temperature that prevails in the muffle, than to observe on samples of porcelain the changes of colour which are undergone by certain preparations very sensitive to differences of temperatures.

PHYLLOXERA

DR. MARION has recently published (Dupont, Paris, 1882) a *résumé* of the results attending the efforts of the Paris, Lyons, and Mediterranean Railway Company to stay the ravages of phylloxera. These efforts were inaugurated in 1876 at a time when the wine growers of Hérault were on the point of relinquishing the struggle. Dumas having demonstrated the great value of alkaline sulphocarbonates as insecticides, this company energetically planned and organised its distribution, with such success that in the period between 1877 and 1881 the number of barrels distributed through their agency rose from 1085 to 14149. The sulphocarbonate is injected twice a year in doses of 12 grammes into holes half a metre apart, being either administered in simple doses or double doses, with an interval of three or four days. The doses vary, however somewhat, according to the nature of the soil and condition of the vines, and much is therefore left to the intelligence of the operator. The remedy acts imperfectly in clayey or stiff soils, and when the ground is saturated.

The first injury manifested when vines are attacked is the loss of their finer radicles, which perish through the suction of the aphid. The consequent loss of nutrition next causes the partial death of old wood and feebleness in the young shoots, followed by a gradual diminution in the fruit. If badly attacked, old vines cannot be saved, as much of the woody stem is dead beyond recovery, but young vines almost always recover under the sulphocarbon treatment, when applied under favourable conditions; new radicles appear, then an increasing luxuriance in the foliary organs, and finally the renewed production of fruit. Dr. Marion strongly advocates the use of this remedy, and sustains his arguments by well selected examples which thoroughly demonstrate its efficacy. It is capable of a wide application, the prices realised for wines in most districts being well able to support its cost.

Other remedies found practicable, but not discussed in Dr. Marion's work, are submersion, and replacement by American stock, with or without grafting. The former can only be practised in comparatively flat or low-lying vineyards in proximity to rivers or canals. These are surrounded by strong embankments of from one to one and a half metres high; and the waters are either let in by mere difference of level at flood times or by centrifugal pumps. The water must not be less than 40 to 50 centimetres in depth, and remain forty to fifty days, and the process is repeated each year. Some waters help to fertilise the soil, and this treatment has invariably produced the best results.

The introduction of American vines has also in certain districts been attended with great success, both in clayey soils, and where the smallness of the vintage per acre precludes the sustained use of costly remedies. The species, however, possess most varying powers of resistance in different soils, and require to be selected with great care. In the vineyards of Medoc, and of high-class vines generally, American stocks are only used for grafting, a clever workman being able to operate on 100 to 200 vines per diem, 70 to 90 per cent. of which will be successful.

Among partly successful remedies may be mentioned the system *Garros*. This consists in uncovering the roots of the vines as far as possible, and treating them with a litre of powdered quicklime, sulphate of copper, and sea-salt. The remedy has been found efficacious, but seems to act, not fatally, on the insects, but in diminishing their number and stimulating the plants to overcome their ravages. The system *Sabaté* is directed towards the destruction of the winter egg, which produces the winged or reproducing stage of the phylloxera. The treatment consists in removing the dead bark from the trunk, and dusting with powdered quicklime, but, like the last, it is not fatal to the insect. A third remedy, that of *Dunay*, consists in exposing the roots of the vine, and coating them from the surface-roots to some 20 centimetres in depth with coal-tar.

I saw, while staying with Leland Cossart, in Madeira, a plan somewhat similar to this practised with great success. Mr. John Leacock, its inventor, removes after the first autumn rain, the soil to a depth of some 20 inches, so as to expose the upper roots, peels off the loose bark and paints the roots with resin dissolved in turpentine, at the same time manuring the vines. This mixture being unaffected by water remains viscid for three or four years, and destroys the insects on their passage up and down. Its cost is less than a halfpenny per vine, and while those so treated were luxuriant in bright green foliage, all around were yellowing and weak.

J. S. GARDNER

THE EXTENSION SEAWARD OF THE WATERS OF THE CHINESE RIVERS

THE following notes, on the extension seaward of the waters of the Yang-tse, were made in the months of September and October (1878), a period of the year when the river first commences to fall, after its waters have attained their maximum height. The four points to which I turned my attention were—the colour and general appearance of the water, the taste, the specific gravity, and the relative amount of chlorides in solution. Owing to the powerful revolving tides of the estuary of the Yang-tse, the river-water and sea-water are churned up together in such a manner that the patches of green and yellow water may be plainly observed, and their line of union as sharply defined. It is from this cause that the density of the water may fluctuate to a very marked degree in the limit of a single mile; and it was not an uncommon experience, on passing from a patch of yellow water into one of green colour, to observe a sudden increase in the density from 1·005 to 1·015. The specific gravity is never constant in the same locality; and it is only by taking all the four points into consideration that a reliable inference could be drawn: thus, the first evidence of the proximity of salt water, which was found at a distance varying from fifteen to thirty miles from Wusung, was not afforded by any marked increase of the density or by any alteration in the taste or colour of the water, but merely by a very perceptible increase in the amount of chlorides held in solution; whilst in the midst of the islands of the Chusan archipelago, which are removed about a hundred miles to the southward, it was often necessary to depend more on the density of the water, on account of the subsidence of the sediment.

Without entering into the details it may be sufficent to state that, whilst the waters of the Yang-tse, according to my observations, became permanently free from sediment, and assumed the more marked characters of sea-water, with a minimum density of 1·018, at a distance of about forty miles east of Wusung, they still retained their yellow colour and turbid appearance, with a density varying between 1·005 and 1·011, on the outskirts of the Chusan archipelago, about a hundred miles to the southward. From these data the conclusion may very naturally be drawn that the main body of the water discharged by the Yang-tse flows comparatively undisturbed in a southerly direction across the Hang-chu Bay to the Chusan archipelago. The southerly extension of the muddy waters of the Yang-tse in the neighbourhood of Chusan[1] must have been a frequent subject of remark to any one approaching Shanghai from the southward, and should he at some subsequent period undertake the voyage from that port to Nagasaki, he will be very probably surprised to find himself, some four or five hours after leaving Wusung, surrounded by the green waters of the Eastern Sea. The situation of the Great Yang-tse bank, which extends one hundred and fifty miles to the north-east from the mouth of the river, would appear to negative the conclusion at which I have arrived; but I am inclined to view this bank—lying as it does rather off the entrances to the river, and composed as it is of fine grey sand—as rather the work of a past period, when perhaps the bulk of the waters found a passage to the north of the island of Tsung-ming, than as being in actual formation at present. That a vast amount of sediment is deposited to the southward of the estuary at the present time we have the most undoubted testimony in the rapid shoaling of the sea amongst the islands of the Chusan archipelago, and along the shores of the Hang-chu Bay, which has caused channels at one time navigable for junks to be now impassable.

With reference to the general effect of the water discharged by the Chinese rivers on the density of the Yellow Sea and of the Gulf of Pe-chili, I may observe that in the month of October I found the specific gravity to rise slowly from 1·019 at the base of the Great Yang-tse bank—a point between fifty and sixty miles east of Wusung—to 1·023 amongst the islands of the Corean archipelago; and that the maximum of 1·024 was attained at a point mid-way between this archipelago and the Shantung promontary. North of this cape the density does not vary in any marked degree, but after the Miau-tau Islands were passed—a group which separates the Gulf of Pe-chili from the Yellow Sea—there was a gradual diminution, until, at our nearest point of approach to the Yellow River, the mouth of which was forty-five miles distant, the specific gravity was 1·021. This slight fall in the density was the *only indication* of our proximity to such a large river as the Hoang-ho—a circumstance which has a particular bearing on the excessive amount of sediment which this river has been estimated to discharge (*vide* NATURE, vol. xxii. p. 487). From this point to the mouth of the Pei-ho the specific gravity continued to decrease, until at a point about twenty-three miles from the mouth of this river, where the discolouration from sediment was first observed, it was 1·020. Thence to the Taku forts the density rapidly fell.

We may thus place the specific gravity of the Gulf of Pe-chili at from 1·020 to 1·023, and that of the Yellow Sea at from 1·022 to 1·024, whilst the difference between these densities and that of oceanic water—1·027—will represent the combined effect of the discharge of the Pei-ho, the Yellow River, and to a less degree of the Yang-tse, on the specific gravities of the seas in question.

I must conclude with an observation on the erroneous notion which the appellation of "Yellow Sea" must convey to the minds of most men. For however much the Yellow Sea may have merited the epithet of "yellow" when it received the waters of the Hoang-ho about a quarter of a century ago—though if an inference is to be drawn from the present condition of the Gulf of Pe-chili it could scarcely have been entitled to it even at that period—it has no claim whatever to it now. Free from sediment and dark green in colour, except in the immediate vicinity of the estuary of the Yang-tse, the Yellow Sea has been more appropriately named by Chinese sailors—"The Black-water Ocean." H. B. GUPPY

H.M.S. *Lark*, Sydney

PROFESSOR GEIKIE IN ARRAN

AMONG the many features which have lent attraction to the study of geology at Edinburgh University, Prof. Geikie's field demonstrations have always held a conspicuous place. Few favourable Saturdays have been allowed to pass, on which he might not be seen rambling with his class through some wooded glen, or climbing some rugged brae, with hammer, sketch-book, and map-case, and every now and then stopping to point out some striking rock section, or to examine a "find," made perchance by one of his students. But at the end of the session, when a week or ten days are devoted to the exploration of some district possessing an interesting geological structure, the "long excursion" is always looked forward to with the keenest delight by professor as well as by students. The first long class-excursion ten years ago was to Arran, and the Professor decided that his last should also be to that island—famous alike for the beauty of its scenery and for the interest attaching to its geological framework. Quarters were taken up at Corrie Hotel on Monday April 24, and that afternoon saw the whole party, numbering about a score, roaming with bags and hammers along the coast towards North Glen Sannox, and making the acquaintance of the coarse red sandstones and brecciated white quartz conglomerates of the Upper Old Red, or Lower Calciferous Sandstone series, which extend in a broad belt round that part of the island. Further inland, a coarse conglomerate made up of well-rounded pebbles of pinkish quartz interstratified with characteristic dark chocolate-coloured sandstones and occasional argillaceous beds, was ascertained some years ago by the Professor to belong to the Lower Old Red Sandstone, and to be brought down by a fault against the schists that fringe the mountainous granitic core of the northern half of the island. He had already made some progress with a geological map of the island on a scale of six inches to a mile, and he now purposes to continue this work with the co-operation of his students. Resuming his geological boundary-lines at Glen Sannox, the party was soon scouring the hillsides far and near, in search of rock-sections and exposures, while he, map in hand, remained within ear-shot, and superintended operations, marking down the lines of junction, and unravelling the geological structures with the skilful hand of one long acquainted with the art of geological mapping. In this way several miles of the boundary between the granite and schists were mapped. In the course of a walk along the steep craggy Suidhe Fearghus, on the north side of Glen Sannox, the trend of this remarkable ridge was found to coincide with that of the vertical joint in the granite, and the deep gashes which indent its profile were observed to be due sometimes to cross joints, sometimes to basalt dykes which, decomposing, have weathered down much faster than the surrounding granite. The view from Caisteal Abhail, the highest peak (2735 feet) of the ridge, was magnificent, extending

---

[1] I may take this opportunity of observing, that on one occasion when off the northern extremity of Chusan, I noticed several large medusæ floating on the surface of the water, which was not only muddy in appearance but had a density of 1·006.

southwards to Ireland, and northwards to the mountains of Mull and Arrochar. On the way down a dyke much more vitreous and obsidian-like than the other Arran pitch-stone, was crossed on the ridge between Caisteal Abhail and Cir Mhor, at the head of Glen Sannox. Another day the steps of the party were turned southwards, and as the red rocks of Glen Shurig, which runs inland from Brodick, had hitherto yielded no organic remains capable of identifying their precise geological position, the Professor instituted a methodical search, which resulted in the discovery of numerous more or less distinct impressions of the lycopod *psilophyton*, clearly proving them to be, as he had inferred, of Lower Old Red Sandstone age. Striking southward into Glen Dubh, the geologists then crossed the very perfect series of moraines, left there by the last valley glacier, and returning by Glen Cloy, and the well-known pitchstone dyke behind the Brodick Schoolhouse. The fossiliferous limestones and shales of Corrie were also well explored, and the position of this strata far down in the heart of the red sandstone series was remarked.

The concluding ramble of the week brought the party to the celebrated dyke of pitchstone at Corriegills, and the quartz-porphyry of Dur Dubh, both possibly of Tertiary age.

The latter rock is alike remarkable for its petrographical characters and its geological structure and history. The quartz in it has crystallised into singularly perfect doubly-terminated pyramids, which can be picked up in handfuls from weathered crannies of the rock. Viewed from the north, the end of the quartz-porphyry ridge is seen to present a remarkable columnar arrangement, the columns radiating from a common centre like the ribs of a fan. The Professor pointed out the resemblance of this structure to that of the west end of the Scuir of Eigg, where a stream of vitreous lava has flowed into and filled up a narrow valley, the sides of which have disappeared, and where the radial structure of the pitchstone is due to the rock having cooled in an approximately semicylindrical gorge, perpendicular to whose sides the columns were formed. In each case the superior durability of the mass has enabled it to resist denudation better than the surrounding rocks, which have long ago been carried off, leaving the lava standing up as a prominent ridge. Most of the students left Brodick by the afternoon steamer on Saturday, after a most enjoyable week of geologising with Prof. Archibald Geikie on the last of the delightful long excursions with his Edinburgh class. H. M. C.

NOTES

THE following telegram from the Special Correspondent of the *Daily News* with the Eclipse Expedition to Egypt, appears in Tuesday's issue:—"Sohag, Monday, 7.20 p.m.: Every facility has been granted to the Eclipse Expedition by the Egyptian Government. The site chosen is close by the bank of the Nile. The instruments are being set up. The Khedive has shown great interest in the Expedition, and the English party, who are his guests, owe much to the arrangements made by the Governor. The officials and natives are everywhere civil and obliging. The weather apparently is quite settled." Under date of May 9 the *Times* correspondent telegraphs as follows:—"The various Eclipse expeditions arriving at Sohag are being entertained by the Khedive. Most important help has been given by Muktar Bey, the Colonel of the Staff representing the Khedive, and the Government, who have also provided a steamer and a military guard."

SINCE we noticed the pamphlet of Prof. Bloxam on the state of affairs at the Royal Military Academy, the subject has been brought before the House of Lords with some prominence; but the main points of complaint appear to have been ignored. If only a portion of the charges in Prof. Bloxam's pamphlet can be sustained, they reveal a very deplorable want of discipline in an important and expensive public establishment, and also a feeling on the part of the authorities that subjects like physics and chemistry are of such minor importance to the scientific soldier as to warrant the withholding of the moral support to maintain discipline that Prof. Bloxam complains of. Some of the statements in the pamphlet are so severe that we hesitated to repeat them, but they do not appear to have been controverted. The position of a professor of a subject that is only looked upon as a sort of useless "extra," deprived to a great extent of the moral support of the heads of the establishment, cannot be a satisfactory one, and if the late Professor's charges and statements are correct, his successor is not to be envied.

WE regret to record the sudden death of Mr. Charles Hockin, at the early age of forty-two, in the midst of an active career as a civil engineer and electrician, on Wednesday, April 26 last. C. Hockin entered St. John's College, Cambridge, in October, 1859, from Aldenham Grammar School, and was elected scholar in the following May. After a successful career in mathematical work at his college he graduated as Third Wrangler in 1863. Choosing engineering as a profession he became pupil to Messrs. Forde and Fleeming Jenkin, and devoted his attention mainly to submarine telegraphy, a province in which his great mathematical abilities found scope, and in which he did much good work. He made, however, opportunities for other purely scientific pursuits, and co-operated with the late Dr. Matthiessen in his researches on the reproduction of electrical standards by chemical means, and also with Sir William Thomson and Clerk-Maxwell in the determination of the B.A. units of electrical resistance and capacity, as well as in the design and construction of the large standard electro-dynamometer for the Committee of the British Association. He was one of the earliest investigators of the resistance of selenium, a material to which so much attention has lately been devoted. His researches on the subject are referred to in the B.A. Report for 1867. In 1872 he joined as a partner the firm of Clark, Forde, and Co., and in the execution of his professional work visited every quarter of the globe, winning the respect and esteem of all with whom he came in contact and the affection of the few he admitted to his intimacy. While there have been few scientific men less eager than he was for personal fame, it is seldom that equal powers have been placed so readily as his were at the service of others, and there was no one whose opinion on the subjects to which he devoted himself was held in greater respect by scientific men. He devoted much time to mathematical investigations chiefly in connection with electricity, but comparatively little of his work has been published by himself, and it is to be hoped that his executors will see their way to the editing and publication of his mathematical papers.

WE learn from Prof. Ray Lankester that another zoological laboratory is to be erected on the shores of the Mediterranean. The French Government has decided to establish at Villafranca near Nice a zoological station, the sole object of which will be to provide accommodation to the numerous naturalists who every year are attracted to this locality by its great reputation as a hunting ground for marine animals. Dr. Jules Barrois, the distinguished embryologist, has been appointed director of the zoological station of Villefranche-sur-Mer. The existence near Nice of a laboratory accessible to strangers, approved by the director, will be an immense boon to English naturalists especially, since the Riviera is not separated from us by a very long journey, is a favourite resort of our countrymen, and is on the whole salubrious. It is the most favourable spot for the study of the Mediterranean fauna by the naturalists of northern countries; and though the new laboratory will by no means compete with or diminish the value of that at Naples, yet it will render possible a short visit to the Mediterranean for the purpose of zoological work, whereas a long sojourn is rendered almost necessary by the much longer journey to Naples. Further it is well known that forms occur at Villafranca which are not found at Naples, as also many occur at Naples not to be found at Villafranca.

AN interesting account has been lately furnished by M. Plateau, the eminent Belgian physicist (who has been blind nearly forty years), of the sensations he experiences in his eyes. He has no sense of objective light even when directing his eyes towards the sun. But his visual field is always divided into spaces, some of which are pretty bright and others sombre or nearly dark, and which merge into each other. Their general tint alternates, in time, between grey and reddish. The relative arrangement of those different spaces is always the same, but the intensity of their tints varies. The central space seems now rather bright, now very dark; above and below, and on the left to the limits of the field, there is sometimes brightness, sometimes darkness, but on the right there is generally a vertical band, nearly black, and beyond this a space which is nearly always bright and reddish. These appearances follow all the movements of the eyes, which probably do not participate in the same way in the tints, but M. Plateau cannot distinguish what belongs to one from what belongs to the other. No connection of the general tint with the work of digestion is observed. The author states that he became blind through looking fixedly at the sun for some time, with a view to observing his after-sensations; it was not till about fourteen years after this that inflammation of the choroid set in, destroying vision, but, during the interval, he often saw coloured and persistent halos round flames, &c., and he advises those who have such vision to consult an experienced oculist.

WITH the approval of the Treasury, Mr. P. Edward Dove, of Lincoln's Inn, has been appointed Secretary to the Transit of Venus Commission.

THE University of London have determined to prosecute with energy before the City of London Livery Companies Commission their claim to administer the funds of Gresham College. For reasons which are given, it is alleged that the founder, Sir Thomas Gresham, intended to found a University for London without limitation to the City proper; and it is urged that his bequest, as at present administered, does not subserve that purpose, being merely devoted to occasional lectures.

SEVERAL commissions have been appointed by the French Government to report on the advisability of undertaking to flood the Algerian Sahara on the plan proposed by M. Roudaire. It is believed, on good grounds, that the report will be in favour of M. Roudaire's great scheme, and that the objections laid before the Academy of Sciences will be put aside.

THE fate of Capt. De Long, the commander of the *Jeannette* Arctic Expedition is now only too certain; Mr. Melville telegraphs from the mouth of the Lena, March 24, that he has found the Captain's dead body and those of his companions, as well as all papers and books. Mr. Melville was to search for the party under Lieut. Chipp in the other cutter.

THE *Daily News* Naples Correspondent writes:—"The illustrious Italian travellers, Capt. Bianchi and Signor Licata, secretary of the Naples African Club, are about to undertake a new expedition, the plan of which is as follows:—From the Bay of Biafra, in Guinea, they will traverse the hitherto unexplored high levels of the Cameroon Mountains in the direction of the Labi Lakes, and study the country in which rise the Congo, Niger, Gazelle Rivers, and Lake Tsad, to find the key of the hydrographic system of tropical Africa. From the lakes they will descend to Lake Luta, which was partly explored by Signor Gassi. They will then traverse the Uganda territory, going north-east towards the Gallas country, already known to Capt. Bianchi, and return to Italy *viâ* Abyssinia and the Red Sea, having thus crossed Africa from west to east. They believe it will take four years to complete this immense journey, which will have principally a scientific aim."

THE *Natal Mercury* records the death of Mr. G. W. Stow, F.R.G.S. The telegram announcing his death reached Bloemfontein from Heilbron *viâ* Bethlehem. He was not only known by his geological surveys of Griqualand West and Natal, but he had been engaged for many years on a work on the Bushmen tribes, and another on the influx of the native races into the southern portion of Africa.

THE last news from Dr. O. Finsch, who has for the last two years and a half been exploring the Pacific Islands, is dated from Thursday Island, in Torres Straits, January 8, 1882 From September, 1880, to March, 1881, he had been in the little coral island of Matupi, near New Britain. After a visit to Sydney and New Zealand, he had gone to Thursday Island; thence he intended to visit North Australia and various islands in Torres Straits, after which he was to go to New Guinea, there to stay several months. Dr. Finsch has already sent to Berlin many boxes of collections in natural history and ethnology. He has already concluded from his researches, that all the Pacific races may be referred back to two stems—a straight-haired (Polynesians and Micronesians), and a crisp-haired (Melanesians and Papuans), and he is doubtful whether there do not exist connecting links between the two.

WE have already given such full details of the objects and methods of the International circumpolar observing stations, that we need only bring the record up to date by giving the list of the stations so far fixed upon, and the countries that are to occupy them:—(1) Point Barrow (north-west America), by the United States; (2) Great Slave Lake, England and Canada; (3) Lady Franklin Bay, United States; (4) Godthaab (West Greenland), Denmark; (5) Pendulum Islands, Germany (probably); (6) Jan Mayen, Austria; (7) Spitzbergen, Sweden; (8) Bossekop, Norway; (9) Sodankylä (67° 24′ N., 26° 36′ E.), Finland (probably); (10) Novaya Zemlya, Russia; (11) Dickson's Harbour, Holland; (12) Mouth of the Lena, Russia. Some of them are already occupied, and all of them will be during the summer.

PROF. ARTHUR GAMGEE will, on Tuesday next (May 16), give the first of a course of four lectures, at the Royal Institution, on Digestion; and Prof. David Masson will give the first of a course of four lectures on Poetry and its Literary Forms, on Saturday (May 20).

WE have received a report of the meeting of the Essex Naturalists' Field Club, held on February 25, when the preservation of Epping Forest in its natural condition was the subject of discussion. It was decided that the Conservators should be petitioned by the Club, on behalf of the natural history students of the metropolis, and a form of petition has been circulated among the various scientific societies and individual naturalists interested in this question. Those wishing to sign the memorial should communicate with the Hon. Sec., Mr. William Cole, Laurel Cottage, Buckhurst Hill, Essex.

APART from absence of soil and moisture, the height of the "timber line," according to Mr. Gannett (*Am. Jour. of Science*, April) is purely a question of temperatures, and he shows that in several parts of Western America the line rises rapidly as the latitude decreases. On the volcanic peaks of the Mexican plateau, *e.g.* it is higher by several thousands of feet than anywhere else in the United States. Even in the same latitude there are very marked differences in its height. The less the elevation of the surrounding country, other things equal, the lower is the limit of timber. Considering that this limit must have approximately the same mean annual temperature everywhere, and that in abrupt ascent there is a decrease in mean annual temperature, of about 1° F. for every 300 feet, Mr. Gannett thought to determine the temperature at the timber line, from that of a station at or near the base (supposed, though not always correctly, to represent the average climate round the base), together with the height. The tabulated figures, for thirteen mountains, &c., yield the mean 30°·4, which is probably very near the true mean annual temperature of the timber line. Should the result hold good, after wider observation, it will afford, Mr. Gannett says, a very valuable and easily obtainable isothermal, and also enable one to estimate the height of the timber line from thermometric stations at the bases of mountain ranges.

On April 26 M. Broch, president, and the delegates of the Bureau International des Poids et Mesures, presented to M. Tirard, the Minister of Commerce, specimens of the facsimile reproductions of the standard metres and kilogrammes preserved since the beginning of the century in the French National Archives. These copies have been executed with an alloy of platinum and iridium, in compliance with the instructions given by MM. Henry Sainte Clair-Deville and Debray. This great work has taken not less than ten years. These facsimiles have been sent to the Bureau at Breteuil, where they will be used in executing the copies ordered by the several nations for their use.

A new edition of Kelland and Tait's "Introduction to Quaternions" has been published by Macmillan and Co. While refraining from making any changes in the late Prof. Kelland's part of the work, Prof. Tait has re-cast his own where he fancied he could improve it.

The Committee of the Sunday Society are more than usually active just now in connection with the motion for extending the opening of museums on Sundays, which Mr. George Howard is to propose in the House of Commons on the 19th inst. On the 17th inst. a National Conference of Delegates from Provincial Towns, Trade Societies, and other organisations, is to be held at the Westminster Palace Hotel under the presidency of Viscount Powerscourt, and in the evening of the same day a large meeting is to take place at St. James's Hall, when addresses are to be delivered by Lord Powerscroft, Lord Dunraven, Lord Dorchester, Mr. Thomas Burt, M.P., Mr. George Howard, M.P., Dr. Richardson, and others.

The additions to the Zoological Society's Gardens during the past week include Six Northern Marsh Tits (*Parus borealis*) from Russia, presented by Mr. A. H. Jamrach; four Pigmy Pigs (*Porcula salviana* ♂ ♀ ♀ ♀) from Nepaul, a Burmese Tortoise (*Testudo elongata*), a —— Terrapin (*Clemmys*, sp. inc.) from Burmah, received on approval; two Green Monkeys (*Cercopithecus callitrichus*) from West Africa, a Grey-headed Love Bird (*Agapornis cana*) from Madagascar, received in exchange; a Water Chevrotain (*Hyomoschus aquaticus*), a Golden-haired Tiger Cat (*Felis chrysothrix*) from West Africa, a Mercenary Amazon (*Chrysotis mercenaria*) from Columbia, three Chiloe Wigeon (*Mareca chiloensis* ♂ ♀ ♀) from Chili, a Silky Bower Bird (*Ptilonorhynchus violaceus*), two Blue-faced Honey-Eaters (*Entomyza cyanotis*) from Australia, a Red-handed Tamarin (*Midas rufimanus*) from Brazil, a Wild Duck (*Anas boscas* ♀), British, four Yellow-billed Cardinals (*Paroaria capitata* ♂ ♂ ♀ ♀) from South America, purchased.

OUR ASTRONOMICAL COLUMN

Anthelm's Nova of 1670.—The vicinity of this object will soon be in a favourable position for observation, and we may once more direct attention to the small star which occupies very nearly the place given by the observations of Hevelius and Picard in 1670. By a recent careful reduction of Picard's observations, the mean place of the object for the beginning of 1670 was found to be in R.A. 19h. 34m. 5s.·3, Decl. + 26° 31′ 42″, which, accurately brought up to 1880, give, R.A. 19h. 42m. 41s.·3, Decl. + 27° 0′ 56″. Near this point we find a telescopic star, which is No. 1814 of the Greenwich catalogue of 1872, the place there assigned differing from that reduced to the year from Picard's observations by + 3s..8 in R.A., and 33″ in declination, and the right ascension for 1670 is open to an error of quite two seconds, and in greater uncertainty than the declination. The small star is followed by one (*b*) 12s.·6, about 4′·9 N., and a second (*c*) at 22s.·4, about 2′·0 N. Its magnitude has been noted as follows:—1852, April 24, 10·11 m.; 1861, May 24, 12 m.; 1872, August 23, = *b*; 1874, November 13, 0·5 m. less than *b*, decidedly less at first view. Another star (*d*) follows the one nearly in the position of *Nova*, 32s.·6, and is N. 1′.7. Prof. Schönfeld found from the observations of Hevelius and Picard combined, a place differing from that given above by – 2s.·8 in R.A., and + 0′·3 in declination.

Variable Stars.—It is known that U Cephei had long been indicated as a probable variable star by the discordant magnitudes given by Schwerd's estimates of magnitude, as arranged by Oeltzen, and when taken in hand for regular examination, its short period was soon detected by Ceraski. Schwerd's estimates were from 6·7 to 10m. It appears by no means improbable that if several other stars for which the magnitudes in the various catalogues are very discordant, were systematically examined, similar cases might be found. For instance, we have 17 ι Andromedæ noted from 3½ to 7m., 16 Leonis Minoris 5 to 8m., 41 ι Aquilæ 3½ to 6m., and 35 Camelopardi 5½ to 8m.; the last, a double star, has already been found to be variable, as regards one component at least; but we have no approximation to the period.

The Comet 1882 *a*.—The following places are derived from the same elements that were employed last week, and are for Greenwich midnight:—

	R.A.	Decl.	Log. distance from	
1882.	h. m.	° ′	Earth.	Sun.
May 13	0 41·0	+74 5		
14	1 4·7	73 33	9·9571	9·9715
15	1 26·9	72 51		
16	1 47·5	72 0	9·9539	9·9481
17	2 6·3	71 1		
18	2 23·4	69 54	9·9518	9·9227
19	2 38·7	68 40		
20	2 52·5	+67 23	9·9508	9·8949

Next week we may probably be in possession of elements which will allow of a close prediction of the comet's track as it approaches the sun. All the later orbits assign for the date of perihelion passage June 10.

BIOLOGICAL NOTES

Fauna of the Suez Canal.—Dr. C. Keller, who is engaged upon a zoological investigation of the Suez Canal, with a special view to determining what exchange of animals may have taken place between the Red Sea and the Mediterranean, has recently sent his first report from Ismailia to the St. Gall Society for Commercial Geography. He states that the exchange is proceeding slowly, owing no doubt to the presence of the lakes of bitter-water through which the canal was traced. The inhabitants of these very lakes seem to have been the first to commence migrations. This fact Dr. Keller has unquestionably ascertained with regard to several species of the lower animals; a particularly interesting case being that of a violet species of sponges, belonging to the fauna of the bitter lakes. This is now migrating in the canal towards the Mediterranean. He named this form *Lessepsia violacea*. Several larger species of fishes, which are now caught in plentiful quantities in the Timsah lake, have migrated there from the Mediterranean; amongst these are *Anarrhichas lupus*, *Solea vulgaris*, and *Polyprion cernium*. Other species have migrated from the Red Sea to the Timsah lake, perhaps to Port Said; amongst these Dr. Keller mentions a large dark green mackerel and several brightly coloured but small Acanthopteri. The canal itself, in the direction from the Timsah lake towards Port Said shows but a poor fauna; that of the bitter lakes is also poor with regard to different species, while the representatives of the few species that are there are excessively abundant.

The Comparative Action of Isomeric and Metameric Compounds on the Growth of Plants.—In an interesting paper on this subject, lately laid before the Royal Irish Academy by Prof. Emerson Reynolds, F.R.S., he calls attention to an apparently neglected subject, and he shows that well-marked differences in physiological activity can be detected with the aid of plants, even in cases of metameric bodies of comparatively simple constitution. The bodies he selected for experiment were ammonium sulphocyanate and its metamer, theocarbamide or sulpho-urea. Both compounds are rich in nitrogen, and therefore capable of supplying a highly important element of plant food; they are easily soluble in water. The experiments were made in the summer of 1881 on plants of *Nicotiana longiflora*. They lasted over three months—August to end of November; a certain number of the plants were watered with rain-water—a certain number with the compounds in solution, otherwise all the plants were exposed to the like conditions. The following were among the chief results:—

	Water-rain.	Theocarbamide.	Sulpho-cyanate.
Total height in inches	31	23	12
Number of leaves	15	14	13
Maximum length of leaves in inches	9·5	15·25	8
Maximum breadth ditto	4·25	6	2·5
Number of seed pods	9	15	0
Ditto well developed	1	11	0

It would then seem (1) that the particular elements of which a body is composed exert less influence on the physiological activity of the compound than the intra-molecular grouping of the component atoms; (2) that in some instances at least differences of physiological activity between metameric bodies can be easily detected by the aid of plants.

Caucasian Milk Ferment.—The inhabitants of the high-lying lands in the Caucasus prepare, by fermentation of cows' milk, a drink which they call kephir. Kephir is used by the inhabitants of the mountains not only as an article of food, but also as a remedy against different diseases. As a ferment in the preparation of this drink, strange white lumps are used, which have a spherical or elliptical shape, and attain the size of from 1 m. to 5 cm. On a microscopical examination of these lumps, they showed that they consisted of two different substances—yeast cells and bacteria. The yeast cells may be regarded as the ordinary form, produced by cultivation, of *Saccharomyces cerevisiæ*, but Kern was unable to get these to the spore-bearing stage. As to the bacteria, they composed the chief part of the little lumps, and were in the Zooglœa state. The vegetative bacteria cells were 3·2 m. to 8m. in length, and ·8 broad. In preparations put up by drying, a distinct cell membrane could be distinguished. Treated after Koch's method, the vegetative cells show at one end a locomotive organ, which resembles a cat-and-nine-tails, of threads. When exposed to the action of acids or a high temperature, the vegetative cells grow out [probably through progressive cell-divisions] into long Leptothrix threads, which change generally precedes the spore-formation stage. The spores are round, always formed in twos in each vegetable cell, and are always placed standing on their ends; even by making use of Hartnack's immersion X, no partition wall could be discovered between the spores. In the Leptothrix-threads rows of spores could be observed, which are, however, always so situated that two spores belong to each cell. The spores while still in the cells are ·8 m. in size; those lying free attain the size of 1 m.; the germinating spores swell up 1·6 m. The germination of the spores generally takes place in such a manner that an exosporium and an endosporium can always be distinguished in them. The thinner endosporium arises out of the thicker exosporium, first as a small excrescence, which gradually increases, developing more and more into a long cylindrical tube, and then begins by cell-division to form vegetative cells. The whole course of the development to the spore-formation, beginning with the vegetative cell to the formation of a similar new cell, was followed. This newly described form of Bacteria, which undoubtedly belongs to the Desmobacteria of Cohn, is in its vegetative state not unlike the *Bacillus subtilis* of Cohn; it is, however, clearly distinguished not only from it, but also from all other kinds of Bacteria hitherto described by its spore-formation, since it always forms in each cell two round spores placed end to end, while in the species of Bacteria hitherto described, only one spore has been noticed in each cell. On account of this sharply-marked feature Kern places this form of Bacteria in a new genus, next to the genus Bacillus, and calls it *Dispora caucasica*, nov. g. et nov. sp. A more exhaustive essay on this subject, with explanatory plates, Kern promises in the next number of the *Bulletin de la Société Impérial des Naturalistes de Moscow*.—Prof. Dr. J. N. Goroschankin assisted Kern by kindly furnishing him with the necessary materials for his work, for which Kern expresses his deepest thanks.—*Botanische Zeitung*, April 21, 1882, p. 264.

New Freshwater Sponges.—Mr. Edward Potts describes three more curious freshwater sponges in the *Proceedings* of the Academy of Natural Sciences of Philadelphia (January 10, 1882, p. 12). One found in September, 1881, near Chadd's Ford, is of a very delicate structure; its framework of skeleton spicules is exceedingly meagre, and slightly bound together, scarcely amounting to a mesh system, and the numerous small white statospheres are found in recesses far larger than themselves. This sponge has been called *Meyenia crateriforma*. Another, forming beautiful green masses, often four to five inches in diameter, and about a quarter of an inch in thickness, was found in Cobb's Creek, near Philadelphia. The surface is irregular, occasionally rising into rounded lobes; the efferent canals are deeply channeled in the upper surface of the sponge, five or six sometimes converging to a common orifice. The statospheres are numerous—rather small. There are two series of birotulate spicules, and it has been called *Heteromeyenia ryderii*. The third species was found at Lehigh Gap, Pa., in November, 1881, and belongs to the genus Tubella. This genus, established by Carter, contained only four species, all from the Amazon River. The new species is small, encrusting, and has been called *P. pennsylvanica*. The skeleton spicules are arranged in a simple series of single non-fasciculated spicules, in the interspaces of which the statospheres are abundant. These spicules are very variable in size and shape, but all are entirely and coarsely spined. The dermal spicules seem absent.

Molluscous Fauna of Moscow.—The molluscous fauna of the neighbourhood of Moscow was very little known until now, the two former works dealing with this subject, by M. Ratchinsky and M. Madéjine, giving only fifty-one species of Gasteropods, that is, only a half of this class of Molluscs which are to be found in the neighbourhood of Moscow. M. Milachevitch fills up this gap (*Bull. de la Soc. des Naturalistes de Moscou*, No. 2) by giving a list of the Molluscs of this region, his determinations of species having been made with the help of, or revised by M. Clessin and Dr. Böttger. It is worthy of notice that of the 109 species described, 11 belong to the region of the Alps, and 17 to the boreal region, 7 of them being common to both regions, and all the Alpine species having been widely spread in Germany during the Quaternary period. A remarkable feature of the Moscow molluscous fauna is the absence of the larger species of *Helix* (*H. pomatia*, *H. nemoralis*, *H. arbustorum*, *H. hortensis*, &c.), whilst they are frequent in other parts of the boreal region—to which the Moscow molluscous fauna belongs too—nearer to the sea. As to the southernlimits of the boreal region in Russia, it is difficult to determine it, but M. Milachevitch supposes it to follow a line drawn from Riga to Tamboff and Saratoff.

Peristaltic Intestinal Movements.—The movements of the intestine have been recently studied by the graphic method, by Signori Mosso and Pelicani (*Reale Ist. Lomb.*), experimenting both on man and the dog. Among other results it appears that at every movement of respiration there occur strong contractions of the rectum. Emotions and cerebral activity have a very manifest influence on the muscular fibres of the intestine, causing strong contraction. Besides so-called spontaneous undulations in the tracings, the direct cause of which is not known, it is possible, the authors prove, to contract at will portions of the intestine that are a considerable distance from the sphimeter muscle. The authors study the influence of changes of temperature on the tonicity of the intestinal walls, indicate the variations of the latter in sleep, digestion, and under influence of medicaments, &c., and show how intestinal movements are related to changes of volume in the forearm and blood-pressure in the carotid.

On the Occurrence of Root-florets in Catananche lutea.—A paper on this subject by B. Daydon Jackson, Sec. L.S., was read before the Linnean Society on May 4.—M. J. A. Battandier, in writing to Sir John Lubbock, pointed out the occurrence of certain large single florets produced directly from the roots of this yellow-flowered composite. Examination of the large series of specimens of this species contained in the herbaria at Kew and the British Museum, showed that these florets were to be found in almost every instance, frequently in great numbers, but usually overlooked from their great resemblance to scales of the root-stock. M. Battandier further stated that the fruit was twice the size of those contained in the normal capitula ; also that the root-florets were not cleistogamic, a fact confirmed by finding specimens showing the anther-tubes and stigmata projecting. Similar instances were also recorded as occurring in two species of Scnipus and a Myosotis.

CHEMICAL NOTES

The formulæ deduced by Guldberg and Waage in their general theory of action of mass have been recently applied, with satisfactory results, by R. Warder (*Amer. Chem. Journ.* iii. No. 5) to the case of saponification of ethylic acetate. W. Ostwald continues his work in the same field ; he has recently studied the actions which occur when certain pairs of salts are fused together in equivalent quantities. His general result is that those salts which have the greatest heats of formation are always produced in greatest quantity. Berthelot's so-called "law of maximum work," viz. that of several possible products of a reaction that salt, in the formation of which most heat is evolved, is alone produced, is regarded by Ostwald as erroneous ; if it were true, chemical equilibrium would be established only in those exceptional reactions wherein some of the reacting bodies underwent dissociation. Berthelot's statement is a return to the old hard and fast ideas on which "tables of affinity" were constructed, ideas long ago overthrown by C. L. Berthollet (*Journ. Pract. Chem.* xxv. 1).

Data continue to be accumulated showing more definitely that there exists a close connection between the structure of molecules and the physical properties of the substances composed of these molecules. Pawlewski has recently published a short account of his researches on the "critical temperatures" of liquid compounds : he states that the critical temperatures of isomeric ethers are identical or very nearly so, that isomers containing "doubly linked" carbon atoms have a higher critical temperature than those in the molecule of which the carbon atoms are singly linked, &c. (*Berichte*, xv. 460).

In an important paper bearing on the same general subject, E. Wilson states, as a result of his collation of many determinations of specific gravities of solids, that it is not justifiable to assign, as is usually done, a certain definite volume to each elementary atom in a compound molecule, but that the volume to be assigned to each atom in a compound molecule depends on the nature of all the atoms in the molecule (*Proc. R. S.*, 32, 457).

In continuance of his experiments on the effects of pressure on chemical changes—before referred to in these notes, Spring states that he has prepared Wood's alloy (melting at 65°) by compressing, at 7500 atmospheres, iron filings, with bismuth, cadmium, and tin, in proper proportions. He has also obtained Rose's alloy (lead, bismuth, and tin), and also brass, by pressure of the constituent metals (*Berichte*, 15, 595).

As the results of an extended series of observations on the structure of metals, Kalischer (*Berichte*, 15, 702) concludes that most of the metals are naturally crystalline, and that when the crystalline structure has been lost by mechanical treatment it can, in most cases, be restored by the action of heat.

PHYSICAL NOTES

An important contribution to physico-mechanical science has been made by M. Berthelot in a memoir communicated to the Académie des Sciences of Paris, upon the rapidity of propagation of a wave of explosion. An explosion in a gaseous compound propagates itself, it would appear far more rapidly than a sound wave could travel in the medium. For example, the velocity of sound in mixed oxygen and hydrogen gases is 514 metres per second, while the explosion propagates itself at 2814 metres per second. M. Berthelot concludes that the wave is therefore not an acoustic wave at all, but a wave of chemical action. The characteristics of this new mode of propagation appear to be the following: uniform velocity of propagation (through tubes); independence of this velocity of the material of the tubes ; tubes of lead and gutta-percha of equal calibre conveying the explosion at equal rates. The velocity in a capillary tube is slightly less than in a wide one, being 2390 metres per second for oxyhydric gas as against 2840 metres. The velocity differs in different mixtures, being 1080 metres per second in a mixture of oxygen and carbonic oxide. The velocity is independent of pressure which, in the experiments varied from 1 to 3 atmospheres. M. Berthelot attempts to identify this velocity with that of the translation of the gaseous molecules at the temperature attained in the explosion, as calculated from the formula of Clausius—

$$v = 29{\cdot}354 \sqrt{\frac{T}{\rho}} \text{ (metres per second) ;}$$

where T is the absolute temperature and ρ the density at 0° of the gas relatively to the air. He *assumes* T as 3000° in each case, which would give for the oxyhydric mixture a velocity of 2000 to 2500 metres per second and 1300 for carbonic acid. M. Berthelot therefore propounds the following view as to the way in which explosive action is propagated. In the film of gas first kindled a certain number of molecules are urged forward with a velocity corresponding to the maximum temperature of the chemical combination. Their shock against the neighbouring films determines there the commencement of chemical action, and so the movement proceeds, a uniform rate being observed except for those molecules which are close to the walls of the tube which give up in the form of heat a portion of their kinetic energy to the solid matter of the tube. A comparison with certain properties of sound waves leads one to doubt the finality of Berthelot's conclusion that these waves are not sound waves ; for Regnault formed a similar retardation of sound-waves in narrow tubes, and it is known that their velocity is independent of pressure, and that it increases with an increase of temperature, and that the temperature which determines the velocity is not the temperature of the mass as a whole but the temperature of the molecules in the actual wave for the time being. The recent experiments of Galloway and of Abel on the propagation of an explosion in air charged with dust and contaminated with gas appear to deal with quite another phenomenon, namely, the velocity of spread of combustion in a space containing particles of solid matter floating in the air, and which has no more direct relation to the velocity of sound than has the velocity with which combustion is propagated along a train of gunpowder or a piece of slow-match.

Another contribution to experimental acoustics we owe to Mr. John Le Conte of California, who has published in the *American Journal of Science* some observations on sound-shadows in water. More than fifty years ago, when Colladon and Sturm were measuring the velocity of sound in the waters of the Lake of Geneva, Colladon remarked on the extreme sharpness with which an acoustic shadow was cast by a projecting wall that ran out into the lake. The greater sharpness of shadows might be expected from the mathematical theory of undulations, for waves of higher pitch than for those of lower, as the wave-lengths of the former are shorter, and therefore less liable to diffraction at the edges of acoustically opaque objects Mr. Le Conte's experiments were almost all made with the waves produced by the explosion of cartridges of nitroglycerine, each containing 15 lbs. of the explosive stuff. These cartridges were being used in blasting a shallow reef in the harbour of San Francisco, and the means taken to observe the propagation of the shock consisted in sinking soda-water bottles and glass tubes filled with air, so as to be wholly or partially concealed behind solid objects such as wooden piles. A cartridge was exploded about 40 feet away from a pile about 12 inches in thickness ; behind this obstacle, and for a distance of 12 feet behind it, a sharply defined sound-shadow could be traced. Another instance is given in the singular preservation of buildings on the occurrence of an explosion at San Francisco when situated within the geometrical shadow of other buildings. Mr. Le Conte seeks to explain the relative sharpness of shadows of explosive sounds by supposing that in this case the very short impulse gives rise to a disturbance whose wave-length is exceedingly short. In connection with the subject, it may be worth while to recall Lord Rayleigh's beautiful experiment on the sound-shadow behind an opaque circular disk, where (as in the case of light for which, as predicted by Poisson and verified by Arago, there is a luminous point at the centre of the shadow), at the centre of the acoustic shadow, a perceptible augmentation of the shrill note of a bird-whistle was observed.

The old device of exploring the vibrating column of air in an organ-pipe to ascertain the position of nodes and loops, by letting down into it a membrane of tissue paper on a wire frame, is familiar. König's method of introducing a small tube communicating with a manometric capsule and a flame indicator, was recently described in our Physical Notes. The latest device for a similar purpose is that of M. Serra-Carpi, who introduces a small microphone supported on an elastic membrane stretched over a wire ring. The microphone is connected by wires to a telephone and a battery. Hardly any sound is heard except when the exploring microphone is at a node, when it causes a buzzing sound to be heard in the telephone. The objection to all these methods is that the pressure of the explorer alters the position of the nodes in the tube. König's apparatus is probably least open to this objection, but it requires a special piece of apparatus of an expensive kind.

THE JOINTING OF ROCKS AND THE CHANNEL TUNNEL[1]

THE writer, referring in the first instance to his "Report" on Jointing, published in vol. xxv. (1875) of the *Transactions* of the Royal Irish Academy, in which the subject is treated of in its purely geological aspect,[2] remarks that his investigations in connection with it entitle him to take a part in the discussion of a question in engineering, which public enterprise has of late elevated to one of international importance.

At the outset, however, he feels himself compelled to express his doubts that rock-jointing has been sufficiently attended to by the active promoters of the proposed Channel Tunnel.

The remarkable divisional structure under consideration, often taken to be analogous to ordinary cracks or fractures due to rock-disruption, is, in the opinion of Prof. King, a phenomenon having only a distant relation in its origin to the latter.

In its normal state, jointing is a fissured condition of rocks—the fissures presenting even, smooth, regular, and close-fitting conjunctive planes, often standing vertically, or in an inclined position. Where the fissures have been affected by stratic disturbances, or have been acted on by water and other erosive agencies, they are more or less open, thereby converted into "crevices." It divides both sedimentary beds and igneous masses; and is separable into two or more series or systems, each having its respective fissures running in parallelism, also in a definite and an independent direction, over areas hundreds of miles in extent; and descending to considerable depths below the earth's surface. The fissures vary in their distance from one another from under half an inch to two or more feet.

That jointing demands the closest attention on the part of engineers engaged in sub-aqueous works requires no other proof than the fact of the utter failure which attended the scheme for opening out, during the famine of 1845-48, a water communication, about four miles in length, between Lough Corrib and Lough Mask, in the west of Ireland. After an expenditure of 40,000*l*. it was found that the jointing in the carboniferous limestone, through which the excavation had been made, carried off all the water. The work had, therefore, to be abandoned; thus resulting in nothing more than a dry ditch!

As regards the chalk and other rocks to be penetrated for the Channel Tunnel, Prof. King admits that they may not be so highly jointed as the much older carboniferous limestone; nevertheless, he shows that the former deposits are not altogether free from dangers, which, to be overcome, require the closest attention.

From the numerous occurrences, noticed by writers, and observed by himself, of faults, true jointing,[3] ordinary disruptive fractures, inclined bedding openings, dry submarine swallow-holes of Pliocene age (now filled with clay, sand, gravel, in some cases containing sub-fossil sea-shells) and rock porosity in the chalk formations of Kent, Prof. King infers that these detriments are equally present in the same deposits, well known to exist at the bottom of the Channel; where some of them cannot but turn out to be sources of water-leakage, greatly interfering with the success of the proposed Channel Tunnel.

Precisely similar detriments, giving rise to the same apprehensions are to be met with on the opposite seaboard of France. Reference may be made to the great lines of fracture which have moulded the river-drainage system of the Bas Boulonnais; and especially to the marvellous jointing (represented by the distinguished geologist, M. Daubrée, in his "Etudes Synthétiques de Géologie," parte prem.), which vertically intersects the chalk cliffs near Tréport, north of Dieppe.

Still, such serious drawbacks Prof. King admits must not be held as unsurmountable. He is fully satisfied that engineering in the present day is quite able to cope with them; but only by an enormous expenditure. It has been proposed to line the Tunnel with concrete; but in his opinion it is absolutely necessary that nothing short of lining it, and in its entire length, with the most resisting, impervious, and endurable stone, should be attempted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The accommodation recently provided for practical biological work has already proved seriously deficient, owing to the rapid growth of the classes in physiology and comparative morphology. The class-room for practical morphology was built to accommodate thirty students working at the same time, and the room for histology, 36. Additional temporary accommodation has been made for an increased number of students, but there are grave inconveniences in consequence. This year there are about fifty-five students in elementary morphology, and twenty in the advanced class; seventy students attend elementary physiology, and about fifteen the advanced course. The only possible alternative to the provision of new rooms, is the division of classes into sections, and repeating the practical work with each section; rendering a large increase in teaching power necessary. Moreover, such an arrangement will interfere with the rule that the practical work belonging to the lecture is gone through immediately after. Under these circumstances it is recommended by the Museums and Lecture Rooms Syndicate that a third floor should be added to the New Museum Building in its central portion, giving a new class-room sixty feet long, and new private rooms for Mr. Balfour's classes, while Mr. Balfour's present class-room could be added to Dr. Foster's department. The cost is estimated at about 1500*l*.

The increasing need for a new lecture-room for biology has not been lost sight of; and it is suggested that it will be advisable to adapt the present bird-room to the purposes of a lecture-room; while the Museum of Comparative Anatomy should be extended so as to be capable of accommodating the birds. This alteration would necessarily involve considerable expense, and it is postponed for the present.

Part I. of the Natural Science Tripos will begin on May 22; Part II. on June 1.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 3.—Photometric researches, by E. Ketteler and C. Pulfrich.—Theory of elliptical double refraction, by E. Lommel.—On differences of tension between a metal and liquids of different concentration, by E. Ketteler.—On galvanic conbinations consisting only of elements, and on the electric conductivity of bromine and iodine, by F. Exner.—Reply to an observation by Herr F. Exner, on Volta's fundamental experiment, by F. Schulze-Berge.—Vaporisation, fusion, and sublimation, by M. Planck.—On new electric figures, and on the gliding of electric sparks, by K. Antolik.—Representation of longitudinal and transversal waves by projection, by R. Weber.—On the theory of stationary motion, by S. Oppenheim.

No. 4.—On the relation of transverse contraction to longitudinal dilatation in bars of isotropic glass, by W. Voigt.—On the electric resistance of vacuum, by E. Edlund.—Transportable instruments for measurement of variations of intensity of terrestrial magnetism, by F. Kohlrausch.—Tangent-compass for absolute measurements, mirror-galvanometer, electro-dynamometer, and magnetometer free of metal, by the same.—Remarks on the mechanical bases of the laws of Ohm and Joule, by E.

---

[1] Abstract of a paper "On the Jointing of Rocks, in Relation to Engineering, especially the Tunnelling of the Strait of Dover," by William King, D.Sc., Professor of Mineralogy and Geology, Queen's College, Galway, read April 24 at the Royal Irish Academy, Dublin.

[2] Jointing in its relation to Physical Geography has been lately treated of by the author in "Thalassa and Xera in the Permian Period," appended to the work—An Old Chapter of the Geological Record, &c., by Professors King and Rowney.

[3] The "many small faults" and "very marked and constant joints"—the latter sometimes containing infiltrated flint—which characterise the chalk "cliffs in many places near Margate" (Whitaker) must be familiar to numbers of the citizens of the metropolis. "Numerous vertical crevices," doubtless originally jointing, intersect a bed of chalk fifty feet thick, close to Dover, at the base of Shakespeare's Cliff.—(W. Phillips.)

Budde.—Experimental researches on the intensity of diffracted light, II., by J. Fröhlich.—Some observations on the works of Herren Lommel, Glazebrook, and Mathieu, by E. Ketteler.—On the condensation of gases on surfaces, by H. Kayser.—Researches on the dependence of the molecular refraction of liquid combinations on their chemical composition, by H. Schröder.—On Legrange's equations of motion, by B. Weinstein.

Journal of the Franklin Institute, April.—A new theory of the suspension system with stiffening truss, by A. J. du Bois (concluded).—Adaptation of Euler's formula to American long column experiments, by W. H. Barr.—The Flannery boiler-setting for the prevention of smoke, by C. A. Ashburner.—Milk, by F. Haines.—The fire-underwriters' regulations respecting the use of the electric light.—On the filtration of water for industrial purposes, by P. Barnes.—The sugar-beet industry, by L. S. Ware and R. Grimshaw.—The Hudson River tunnel, by S. H. Finch.

Bulletins de la Société d'Anthropologie de Paris, tom. iv. fasc. iv. Paris, 1881.—This, the latest quarterly number of the *Bulletins*, contains the concluding part of M. Topinard's paper on his facial goniometer.—Observations by L. Manouvrier on the relations between the weight of the cranium and that of the maxillaries and the femur, with a view of trying to determine the relations between the several parts of the body connected with the cerebral, digestive, and motor functions.—Reports by M. Ledouble of a case of variation in the clavicular trapezius; and on the occurrence in man of the abnormal muscle named by Wood, the supercostalis"; a case of atavism in the occurrence, in a woman, of the flexor profundus digitorum of the ourang-outang, by M. Chuzinski.—On the crania of criminals preserved at Brest, by M. Corre.—On the craniology of criminals, by Dr. Ardouin, who also contributes an interesting paper on the results of the Medical Statistical Tables of Japan, published at Tokio in 1880.—M. Leon Metchnikoff gives the result of his ethnological observations while in Japan on the different races occupying the country, and his views as to their probable origin.—M. Verneau considers the type and origin of the ancient inhabitants of the Canaries; and M. Manouvrier describes at great length the result of his observations on eleven natives of Tierra del Fuego, in the Jardin d'Acclimatation, at Paris. His remarks gave rise to prolonged discussions among the Members of the Society, and were supplemented by a communication from M. Topinard, based on personal observation of these savages, and by a *résumé* by M. Hovelacque of all that is known of the people and their country, through the reports of English and French travellers.—M. Magitot describes the abnormal characters of a dwarf, presented last October by Baron Larrey to the Académie de Médecine; and M. de Quatrefages reports the case of a dwarf smaller than Tom Thumb, and in whom, he believed, that the disproportionally large size of the head was due to hydrocephalus.—M. Parrot brought forward a case of megaloglossis, combined with idiocy, in a child of two years of age.—M. Laborde presented to the Society his essay on the experimental and morphological function of the semi-circular canals in animals, in which be believes we may discover that of a "sensitvo-motor" apparatus, intended to render the sense of hearing more complete. M. Delaunay, in summing up the conclusions he has arrived at in his labours in the field of general pathology, considered the various degrees of liability towards certain diseases shown at different ages, by either sex, and among different races. The only contributions towards palæontological inquiry contained in this number are: M. Hamy's report of the progress of the excavations at Bollwiller, whose deposits would appear to belong to the latest neolithic age; Prof. Carl Vogt's communication of the discovery by M. Roth, in the Pampas of La Plata, of a human skeleton lying below the carapace of a fossil glyptodon; and the presentation, by M. Vinson, of a chromolithographic reproduction of a celto-iberian inscription, found near Siguenza. M. Vinson is of opinion that we have as yet no authority for accepting the theory of any close affinity of the Basques with the ancient Iberians.

Memorie della Società degli Spettroscopisti Italiani, March.—Solar observations made at the Royal Observatory of Palermo in the fourth quarter of 1881, by Prof. Ricco.

SOCIETIES AND ACADEMIES

London

Zoological Society, May 2.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—Before commencing the usual proceedings, the president called attention to the fact that one of the communications made to the previous meeting was from the pen of Mr. Charles Darwin; and took the opportunity of referring to the labours and character of the illustrious naturalist, whose work had so profoundly modified not only zoological science, but so many other departments of human thought.—Mr. Sclater exhibited a drawing of a Tapir presented to the Society by Mr. Fritz Zurcher in August last, which had been captured on the Yuruari River in Venezuela. Mr. Sclater observed that in form and colour this animal seemed to agree better with *Tapirus dowii* than with the ordinary *T. americanus*, and suggested that it was quite likely that the former species might be the Tapir of the northern coast-region of Columbia and Venezuela.—Mr. J. E. Harting, F.Z.S., made some remarks on the desirability of adopting a standard of nomenclature when describing the colours of natural objects.—Dr. Hans Gadow, C.M.Z.S., read a paper on the structure of feathers in relation to their colour, in the course of which he endeavoured to show how the optical appearances of the various colours met with in the feathers of birds were produced.—Prof. Flower, F.R.S., gave an account of the cranium of a Cetacean of the genus *Hyperoodon* from the Australian Seas, upon which he proposed to found a new species, *H. planifrons*.—A communication was read from Dr. O. Staudinger containing the description of some new and interesting species of Rhopalocera from the New World.—A communication was read from Mr. H. J. Elwes, F.Z.S., containing a description of a collection of butterflies made on the Tibetan side of the frontier of Sikkim, amongst which were examples of several species new to science.—A communication was read from Mr. Edgar L. Layard, F.Z.S., describing a new species of Parrot of the genus *Nymphicus* from Uvéa, one of the Loyalty group, which he proposed to call *Nymphicus uvænsis*.

Geological Society, April 16.—J. W. Hulke, F.R.S., president, in the chair.—The President remarked that it would argue a degree of indifference with which the Society could not be charged, if the meeting were to proceed to the transaction of the ordinary business, without some reference to the sad loss sustained by the whole scientific world within the last few days, in the death of that illustrious naturalist, whose remains had been consigned that morning to their last resting-place at Westminster. He added that the spectacle presented by the vast assemblage of people who came together to witness the obsequies of Mr. Darwin, was of the most soul-stirring kind, and constituted the grandest conceivable testimony of respect for the memory of the distinguisbed philosopher who had just passed from among us.—S. S. Buckman, Hugh Salvin Holme, Collet Homersham, and Joseph B. Tyrrell were elected Fellows of the Society.—The following communications were read:—On fossil Chilostomatous Bryozoa from Mount Gambier, South Australia, by Arthur W. Waters, F.L.S., F.G.S.—*Thamniscus*: Permian, Carboniferous, and Silurian, by George W. Shrubsole, F.G.S.—On the occurrence of a new species of *Phyllopora* in the Permian limestones, by George W. Shrubsole, F.G.S.—On the relations of the Eocene and Oligocene strata in the Hampshire Basin, by Prof. John W. Judd, F.R.S., Sec.G.S. The section at Whitecliff Bay, in the Isle of Wight, affords us the means of determining the true order of succession of nearly 2000 feet of Tertiary strata, and is therefore employed as a standard to which to refer the strata seen in sections where the order of succession is not so clear. The author supported the views of Prof. Prestwich as to the limits of the Bracklesham series, as opposed to the opinions expressed on the subject by the Rev. O. Fisher. He pointed out the confusion which has arisen from the correlation of certain strata in the Hampshire basin with the barren Lower and Upper Bagshots of the London area, in which fossils are so rare as to render their geological age somewhat doubtful. To the Lower Bagshot some authors have referred 660 feet of the strata seen at Alum Bay; while other authors have restricted that name to about 73 feet of the same section. The age of the Upper Bagshot of the London basin is admitted by all authors to be very doubtful. The only way to avoid the confusion unavoidable from using the same names for strata, the correlation of which was so hypothetical, was to employ local names for both sets of beds. He proposed to refer to the freshwater sands below the Bracklesham and Bournemouth strata, containing a distinctive flora, as "the Studland beds," and the sands above the Barton clay by the old name of "the Headon Hill Sands." Above these sands are a series of clays only about 40 feet thick at Whitecliff Bay, but much thicker at Headon Hill and Hordwell Cliff. These sands and clays form the Headon group; they consist of freshwater strata with bands of limestone and lignite, but including numerous inconstant intercalations of layers containing marine shells, for the most part much dwarfed. The age of the Headon group, as shown by the fossils which it contains, is that of "the zone of *Cerithium concavum* of continental authors. The brackish-water Headon group is succeeded at Whitecliff Bay by nearly 100 feet of purely marine strata. These marine beds, which had been shown to rest on an eroded surface of the Headon beds, contain the remarkable fauna which had been recognised by many British and foreign geologists as that of the Lower Oligocene. Similar strata with the same fossils are found in the New Forest, at Lyndhurst, Brockenhurst, Roydon, and other points, and there also attain a considerable thickness. It was pointed out that this marine series is quite distinct from the Headon, or zone of *Cerithium concavum*, with which it had been confounded. The author had been very severely criticised for the views which he had put forward in a former paper as to the manner in which the Brockenhurst series is represented in the section at the west end of the Isle of Wight. There was much difficulty in these variable estuarine beds in correlating the beds seen in Colwell Bay with those exposed in the cliffs of Headon Hill. With several previous authors on the subject, he maintained that the great series of sandstones and limestones forming Warden Point and How Ledge are continuous with those exposed in the face of Headon Hill, and, consequently, that the marine beds of Colwell Bay, overlying those limestone series are younger than the brackish-water bands interstratified with the Heddon beds of Headon Hill. His critics, however, insisted that these two beds agreed with one another in such a manner that they must be regarded as parts of the same bed, separated by denudation. In opposition to this view, it was pointed out that the Colwell Bay bed is of the most inconstant character, and long before reaching Headon Hill is seen to be on the point of thinning out and disappearing altogether. In conclusion, the author pointed out that his own interpretation of the succession and correlation of the strata in the Hampshire basin brings them into complete harmony with that which is maintained by the great majority of continental geologists, while that of his critics appeared to be hopelessly irreconcileable with their views.

Chemical Society, May 4.—Dr. Gilbert, president, in the chair.—Prof. J. Dewar, F.R.S., delivered a lecture on the recent development of the theory of dissociation. The lecturer, after referring to the earlier work of Black on "Physical Chemistry," pointed out the origin of the term dissociation, and the experiments made thereon by Deville. Troost proved that dissociation is a function of the temperature, that it is independent of mass, and that the action is reversible; the process resembles in many respects the condensation and volatilisation of a vapour. The experiments in which vapours are conducted along heated porous tubes, only prove that dissociation takes place, but do not tell us the extent of the dissociation. Exact determinations of the partial pressures obtained by heating various substances, as ammoniochloride of silver, water, &c., to certain temperatures have been made, and thus curves have been drawn, which, by inspection, show the pressure necessary to prevent the decomposition of a substance at any particular temperature. Recent investigations have shown that solid substances have a temperature analogous to the "critical point" of gases, above which they cannot exist; thus, when hydrogen sulphide and water are subjected to great pressure at low temperatures, a crystalline hydrate is formed, but above 40° C. this substance cannot be shown to exist, however great the pressure may be. If a mixture of hydrogen and iodine be heated to about 300° C., some hydriodic acid is formed; if hydriodic acid be heated to 300° C., free hydrogen and iodine are formed, and the resulting mixture of hydrogen, iodine, and hydriodic acid has in each case the same composition. The lecturer then explained the cycle of Carnot, and showed how a formula could be deduced from it, by which the latent heat of a chemical compound could be calculated. The importance of the researches of Andrews on the liquefaction of carbon-dioxide was insisted upon, and the analogy of some of the results with the dissociation of chemical bodies pointed out. In conclusion, the author discussed the probability of the dissociation of elements in the sun's atmosphere, and reasoning from a legitimate extension of the known laws of dissociation, inferred that if hydrogen be considered as the elementary form of matter, the sun's atmosphere is most unfavourable to dissociation.

Anthropological Institute, April 25.—Hyde Clarke, vice-president, in the chair. It was announced that Alfred Morrison, F.G.S., and Frederick Harold had been elected Members of the Institute.—The Chairman referred at some length to the great loss that anthropological science had suffered by the death of Mr. Darwin, an Honorary Member of the Institute; Prof. Flower, F.R.S., also offered a tribute to Mr. Darwin's memory. Mr. E. H. Man read a second paper on the aboriginal inhabitants of the Andaman Islands. He touched first upon the important subject of language, and pointed out certain peculiarities connected with the varying use of several sets of possessive pronominal adjectives with particular classes of nouns: in expectation at an early date of a paper on the South Andaman language by the president of the Philological Society, this subject was but briefly dealt with by the author, who next proceeded to describe the Andamanese system of adoption and the recognised degrees of affinity, especially as bearing on the question of marriage, bringing to notice at the same time the erroneous opinions hitherto held on this latter point, as also anent their death and burial customs. Numerous superstitions, beliefs, and traditions were related, the latter treating of the account given by the aborigines regarding the Creation, Deluge, and Dispersion. Mr. Man was careful to state that he had taken the precaution to obtain his information from members of distant tribes who had had no opportunity of intercourse with Europeans or other aliens residing at Port Blair, and added that it was extremely improbable, for the reasons noted in his paper, that any previous generations of these islanders, within historic times, by whom these traditions had been handed down, could have obtained their versions from strangers.

Royal Horticultural Society, April 25.—Sir J. D. Hooker, in the chair.—*Larches attacked by larvæ:* Mr. Maclachlan reported upon some specimens of larch twigs received from Mr. R. Clutton, of Hartwood, Reigate, who stated that thousands of young larches were attacked by larvæ at Box Hill—"the affected trees swarm with little grubs which move about in their cocoons, and seem to suck the juices from the young foliage, leaving it dead, and so kill the trees." They proved to be the larvæ of a minute moth, *Coleophora laricella*, which lays its eggs on the twigs or buds. The larvæ hatched in autumn construct cases of cuticle, &c. The young *autumn* larvæ attach their cases to the young leaves in spring, which they soon mine and destroy. Mr. Maclachlan is of opinion that the damage done by this insect is not likely to seriously injure larches. He remarked that Box Hill being chalk and dry, was not well suited for the growth of larches.—*Fertilisation of Hoya:* Mr. W. G. Smith referred to this subject, and exhibited flowers with flies attached to the glutinous disks of the pollen-masses. The Hoya is highly fragrant. This fragrance is very attractive to insects, which are necessary for fertilisation of this plant. The pollinia are concealed, excepting the dark viscid disks, which are exposed. When an insect alights on the flowers, one foot at least slips and gets caught by one of the fine little glutinous disks. In its effort to escape two, three, or even four other feet are almost sure to get similarly caught. The insect then tries with all its power to free its limbs. If successful the pollen-masses are withdrawn out of the pouches by the feet. The basal appendages of each pair of pollinia are elastic, and when in the pouch they are like an extended spring, but the instant the masses are drawn out, the spring closes, and the two pollen masses quickly cross each other and hold tightly on to the insect's little claws. If the insect is weak, it cannot withdraw its legs at all, and so perishes on the flower; but if strong, it flies away with one to five pairs of pollinia clasped round its feet. Sometimes an insect breaks part of its leg off in trying to withdraw it. The five stigmas are not ready to receive the pollen at the time the pollen is mature; so that it is only when the insect realights on some neighbouring Hoya-flower in a more advanced stage of growth that cross-fertilisation takes place by its treading on the exposed stigmas.

EDINBURGH

Royal Society, May 1.—Mr. Milne Home, vice-president, in the chair.—Prof. Piazzi Smyth, Astronomer-Royal for Scotland, read a paper on some points in the meteorology of Madeira, both absolute and comparative. By a careful comparison of the mean monthly temperatures, the maximum temperatures, and the mean daily range, during the months of June and July at Madeira and Lisbon, it appeared that the temperature at the former was markedly more equable. A like comparison was also instituted for the corresponding *annual* variations at Madeira, Lisbon, Jerusalem, and Scotland, and the same wonderful equableness was shown to exist. Observations with the wet- and dry-bulb thermometer, and spectroscopic indications of the "rain-band" proved the climate of Madeira to be at the same time remarkably humid, which at once explains its cold summers and warm winters. This striking humidity the author traced to the influence of the Gulf Stream, a branch of which trends south from the Bay of Biscay past the coast of Portugal. That the ocean waters around Madeira are peculiarly warm, was demonstrated by the late Sir Wyville Thomson in the *Challenger* Expedition. The abundant presence of watery vapour in the atmosphere also seems to have a marked influence upon the flora and fauna, which are very different from what would be expected when latitude alone is considered.—Mr. P. Geddes communicated a paper by Mr. F. E. Beddard, B.A., on the anatomy and histology of *Pleurochacta Moscleyi*, a new genus and species of earthworms, which had been brought home by Prof. Moseley from Ceylon. The chief characteristics of this species noted were, that the setæ are not arranged in continuous lines round the body, but in two lateral groups, that there are no segmented organs, and that the capillaries extend into the hypoderm, as in the leech.—Prof. Heddle, in the first of three notes, described a leaf-bed which he had discovered at the base of a high precipice at the north-west corner of the island of Canna. The bed consists of a highly laminated brown clay, easily split by tapping or by inserting the edge of a knife. This clay, when it comes down to the water's edge, is acted upon by the waves to form the so-called Fuller's earth. In the second note, the author intimated that the inner Hyskier—a group of skerries some nine miles from Canna—was formed of the pitchstone porphyry of the Scuir of Eigg, which is about twenty-two miles distant. The third note related to a supposed organism from the marble of Sutherland, which the author, from his intimate acquaintance with the structure and mode of occurrence of minerals, was certain was not a mineral. A specimen had been sent to Dr. Carpenter, who, without any knowledge as to where it had been got, described it as being very Eozooic.—Mr. J. Aitkin communicated a brief note on the selective absorption of sea-water for light, on which he had made some spectroscopic observations.

PARIS

Academy of Sciences, May 1.—M. Jamin in the chair.—The death of Mr. Darwin was commented upon by the President and by M. de Quatrefages.—On some reactions of bichloride of mercury, by M. Debray.—On the employment of liquefied gases, and particularly ethylene, for production of low temperatures, by M. Cailletet. A thermometer immersed in liquid ethylene indicated about – 105°; whereas protoxide of nitrogen boils at – 88°. In utilisation the liquid was, on opening an orifice in the receiver, projected through a glass tube on the apparatus to be cooled. Suddenly diminishing the pressure of compressed oxygen cooled to at least – 105°, one observes tumultuous ebullition for a little; (at – 88° oxygen gave merely a fine mist). Ethylene has the property of remaining liquid and transparent at temperatures where protoxide of nitrogen and carbonic acid become solid and opaque.—Separation of gallium, by M. Lecoq de Boisbaudran.—Report on a memoir of M. C. Stephanos, entitled "Memoir on Groups of Binary Forms having the same Jacobian."—Determination of the difference of longitude between Paris and Besançon, by MM. Barnaud and Leygue. A chronometric observatory is being founded at Besançon, for the benefit of the watchmaking industry there, and the difference of longitude between the site chosen and the Montsouris Observatory is found to be 14m. 36·267s.—Developments in series of a holomorphous function in an area limited by arcs of the circle, by M. Appell.—On certain ternary quadratic forms, by M. Picard.—On photographs of the spectrum of the nebula of Orion, by Prof. Draper.—On the polarisation of electrodes and on the conductivity of liquids, by M. Bouty. From experiments in which the electromotive method of M. Lippmann was applied to measuring the conductivity of acidulated water with a very weak electromotive force (*e.g.* that of a zinc-cadmium element), he concludes that a liquid has only one way of conducting electricity (not *two*, an *electrolytic* and a *metallic*, as some physicists suppose), whatever the special phenomena of the electrodes.—Influence of a metal on the nature of the surface of another metal placed at a very small distance, by M. Pellat. Two metal surfaces placed opposite each other at an interval of a few millimetres or tenths of a millimetre, have their superficial layers temporarily altered (as one finds on measuring the difference of potential); after separation the change gradually disappears. The author regards the action as not electric, but purely material, and depending on the nature of the influencing metal (it is great with lead, less with copper, *nil* with zinc). Metals seem to emit, at ordinary temperature, a volatile substance, which, deposited on the surface of objects, chemically modifies their nature.—On the liquefaction of ozone, by MM. Hautefeuille and Chappuis. By compressing, at about 125 atm., a mixture of oxygen and ozone in a bent tube, part of which was cooled with a jet of liquid ethylene (see above), they obtained ozone in liquid drops of a dark indigo blue colour. The vaporisation of the liquid is not very rapid, even at atmospheric pressure.—Action of insoluble metallic sulphides on a solution of acid sulphate of nickel in presence of sulphuretted hydrogen, by M. Baubigny.—Oxidation of pyrogallol in presence of gum arabic, by MM. de Clermont and Chautard.—Chemical study of various products of Uruguay, by M. Sace. This relates to caoutchouc from various fig trees, the camphor tree, a blue-flowered vetch, and chickweed.—Observations relative to a group of fossil Suidæ, whose dentition has some Simian characters, by M. Filhol. These fossils are from the upper eocene. Other points of similarity are the shortening of the skull and the form of the temporo-maxillary articulation.—Researches on the anatomy of some Echinida, by M. Kahler.—The Grotto Lympia, by M. Riviere. He finds evidence of the contemporaneity of the brecciform deposits of this grotto (discovered at Nice in 1878, and containing remains of *Elephas*, *Lagomys*, *Capraprimigenia*, *Cervus*, *Bos*, &c.), with quaternary man.—On the reptiles found in the gault of the east of France, by M. Sauvage. Eleven have been discovered. *Inter alia*, crocodiles existed of much larger size than those of the Cambridge strata. The principal Dinosaurian was a *Megalosaurus* (*superbus*) of gigantic size, differing in several features from the *M. Bucklandi* of the oolite in England.—A hypsometric map of the rivers of European Russia, by Col. de Tillo, was presented by M. Daubrée. It is observed that the principal water-courses of that country change pretty abruptly in general direction. M. Holtz noted several observations relative to intermittent springs.

CONTENTS

THURSDAY, MAY 18, 1882

CHARLES DARWIN

I.

THE object of this notice is to give a brief account of the life, and a proportionately still more brief account of the work, of Mr. Darwin. But while we recognise in him perhaps the greatest genius and the most fertile thinker, certainly the most important generaliser and one of the few most successful observers in the whole history of biological science, we feel that no less great, or even greater than the wonderful intellect was the character of the man. Therefore it is in his case particularly and pre-eminently true that the first duty of biographers will be to render some idea, not of what he did, but of what he was. And this, unfortunately, is just the point where all his biographers must necessarily fail. For while to those favoured few who were on terms of intimate friendship with him, any language by which it is sought to portray his character must seem inadequate, to every one else the same language must appear the result of enthusiastic admiration, finding vent in extravagant panegyric. Whatever is great and whatever is beautiful in human nature found in him so luxuriant a development, that no place or chance was left for any other growth, and in the result we beheld a magnificence which, unless actually realised, we should scarcely have been able to imagine. Any attempt, therefore, to describe such a character must be much like an attempt to describe a splendid piece of natural scenery or a marvellous work of art; the thing must itself have been seen, if any description of it is to be understood.

But without attempting to describe Mr. Darwin's character, if we were asked to indicate the features which stood out with most marked prominence, we should first mention those which, from being conspicuous in his writings, are already more or less known to all the world. Thus, the absorbing desire to seek out truth for truth's sake, combined with a characteristic disregard of self, led not only to the caution, patience, and candour of his own work—which are proverbial—and to the generous satisfaction which he felt on finding any of his thoughts or results independently attained by the work of others; but also to a keen and vivid freshness of interest in every detail of a new research, such as we have sometimes seen approached by much younger men when the research happens to have been their own. And indeed what we may call this fervid youthfulness of feeling extended through all Mr. Darwin's mind, giving, in combination with his immense knowledge and massive sagacity, an indescribable charm to his manner and conversation. Animated and fond of humour, his wit was of a singularly fascinating kind, not only because it was always brilliant and amusing, but still more because it was always hearty and good-natured. Indeed, he was so exquisitely refined in his own feelings, and so almost painfully sensitive to any display of questionable taste in others, that he could not help showing in his humour, as in the warp and woof of his whole nature, that in him the man of science and the philosopher were subordinate to the gentleman. His courteous consideration of others, also, which went far beyond anything that the ordinary usages of society require, was similarly prompted by his mere spontaneous instincts of benevolence.

> For who can always act? but he
> To whom a thousand memories call;
> Not being less but more than all
> The gentleness he seem'd to be,
>
> Best seem'd the thing he was, and join'd
> Each office of the social hour
> To noble manners, as the flower
> And native growth of noble mind;
>
> Nor ever narrowness or spite,
> Or villain fancy sweeping by,
> Drew in the expression of an eye,
> Where God and Nature met in light.

And this leads us to speak of his kindness, which, whether we look to its depth or to its width, must certainly be regarded as perhaps the most remarkable feature of his remarkable disposition. The genuine delight that he took in helping every one in their work—often at the cost of much personal trouble to himself—in throwing out numberless suggestions for others to profit by, and in kindling the enthusiasm of the humblest tyro in science; this was the outcome of a great and generous heart, quite as much as it was due to a desire for the advancement of science. Nothing seemed to give him a keener joy than being able to write to any of his friends a warm and glowing congratulation upon their gaining some success; and the exuberance of his feelings on such occasions generally led him to conceive a much higher estimate of the importance of the results attained than he would have held had the success been achieved by himself. For the modesty with which he regarded his own work was no less remarkable than his readiness enthusiastically to admire the work of others. In fact, to any one who did not know him well, this extreme modesty, from its very completeness and unconsciousness, might almost have appeared the result of affectation. At least, speaking for ourselves, when we first met him, and happened to see him conversing with a greatly younger man, quite unknown either in science or literature, we thought it must have been impossible that Mr. Darwin—then the law-giver to the world of biology—could with honest sincerity be submitting, in the way he did, his matured thought to the judgment of such a youth. But afterwards we came fully to learn that no one was so unconscious of Mr. Darwin's worth as Mr. Darwin himself, and that it was a fixed habit of his mind to seek for opinions as well as facts from every available quarter. It must be added, however, that his tendency to go beyond the Scriptural injunction in the matter of self-approval, and to think of *others* more highly than he ought to think, never clouded his final judgment upon the value of their opinions; but, spontaneously following another of these injunctions, while proving all things, he held fast only to that which was good; in malice be ye children, but in understanding be ye men.

On the whole, then, we should say that Mr. Darwin's character was chiefly marked by a certain grand and cheerful simplicity, strangely and beautifully united with a deep and thoughtful wisdom, which, together with his illimitable kindness to others and complete forgetfulness of himself, made a combination as lovable as it was venerable. It is, therefore, not to be wondered at that no man ever passed away leaving behind him a greater void of enmity, or a depth of adoring friendship more profound.

But, as we have said, it is impossible to convey in words any adequate conception of a character which in beauty as in grandeur can only, with all sobriety, be called sublime. If the generations are ever to learn, with any approach to accuracy, what Mr. Darwin was, his biographers may best teach them by allowing this most extraordinary man to speak for himself through the medium of his correspondence, as well as through that of his books; and therefore, as a small foretaste of the complete biography which will some day appear, we shall quote a letter in which he describes the character of his great friend and teacher, the late Prof. Henslow, of Cambridge. We choose this letter to quote from on account of the singular manner in which the writer, while describing the character of another, is unconsciously giving a most accurate description of his own. It is of importance also that in any biographical history of Mr. Darwin, Prof. Henslow's character should be duly considered, seeing that he exerted so great an influence upon the expanding powers of Mr. Darwin's mind. We quote the letter from the Rev. L. Jenyns' Memoir of the late Prof. Henslow.

"I went to Cambridge early in the year 1828, and soon became acquainted, through some of my brother entomologists, with Prof. Henslow, for all who cared for any branch of natural history were equally encouraged by him. Nothing could be more simple, cordial, and unpretending than the encouragement which he afforded to all young naturalists. I soon became intimate with him, for he had a remarkable power of making the young feel completely at ease with him, though we were all awe-struck with the amount of his knowledge. Before I saw him, I heard one young man sum up his attainments by simply saying that he knew everything. When I reflect how immediately we felt at perfect ease with a man older, and in every way so immensely our superior, I think it was as much owing to the transparent sincerity of his character as to his kindness of heart, and perhaps even still more to a highly remarkable absence in him of all self-consciousness. We perceived at once that he never thought of his own varied knowledge or clear intellect, but solely on the subject in hand. Another charm, which must have struck every one, was that his manner to a distinguished person and to the youngest student was exactly the same: to all the same winning courtesy. He would receive with interest the most trifling observation in any branch of natural history, and however absurd a blunder one might make, he pointed it out so clearly and kindly that one left him in no way disheartened, but only determined to be more accurate the next time. So that no man could be better formed to win the entire confidence of the young and to encourage them in their pursuits. . . .

"During the years when I associated so much with Prof. Henslow, I never once saw his temper even ruffled. He never took an ill-natured view of any one's character, though very far from blind to the foibles of others. It always struck me that his mind could not be well touched by any paltry feeling of envy, vanity, or jealousy. With all this equability of temper, and remarkable benevolence, there was no insipidity of character. A man must have been blind not to have perceived that beneath this placid exterior there was a vigorous and determined will. When principle came into play, no power on earth could have turned him an hair's breadth. . . .

"In intellect, as far as I could judge, accurate powers of observation, sound sense, and cautious judgment seemed predominant. Nothing seemed to give him so much enjoyment as drawing conclusions from minute observations. But his admirable memoir on the geology of Anglesea shows his capacity for extended observations and broad views. Reflecting over his character with gratitude and reverence, his moral attributes rise, as they should do in the highest characters, in pre-eminence, over his intellect."

Charles Robert Darwin was born at Shrewsbury on February 12, 1809. His father was Dr. R. W. Darwin, F.R.S., a physician of eminence, who, as his son used frequently to remark, had a wonderful power of diagnosing diseases, both bodily and mental, by the aid of the fewest possible number of questions; and his quickness of perception was such that he could even divine, in a remarkable manner, what was passing through his patients' minds. That, like his son, he was benevolently inclined, may be inferred from a little anecdote which we once heard Mr. Darwin tell of him while speaking of the curious kinds of pride which are sometimes shown by the poor. For the benefit of the district in which he lived Dr. Darwin offered to dispense medicines *gratis* to any one who applied and was not able to pay. He was surprised to find that very few of the sick poor availed themselves of his offer, and guessing that the reason must have been a dislike to becoming the recipients of charity, he devised a plan to neutralise this feeling. Whenever any poor persons applied for medical aid, he told them that he would supply the medicine, but that they must pay for the bottles. This little distinction made all the difference, and ever afterwards the poor used to flock to the doctor's house for relief as a matter of right.

Mr. Darwin's mother was a daughter of Josiah Wedgwood. Little is at present known concerning his early life, and it is questionable whether we can hope to learn much with reference to his boyhood or youth, till the time when he entered at Edinburgh. We can, therefore, only say that he went to Shrewsbury School, the head-master of which was at that time Dr. Butler, afterwards Bishop of Litchfield. He was sent to Edinburgh (1825) because it was intended that he should follow his father's profession, and Edinburgh was then the best medical school in the kingdom. He studied under Prof. Jameson but does not seem to have profited at all by whatever instruction he received; for not only did it fail to awaken in him any special love of natural history, but even seems to have had the contrary effect.

The prospect of being a medical practitioner proving distasteful to him, he was, after two sessions at Edinburgh, removed to Christ's College, Cambridge, with the view of his entering the Church. He took his B.A. in 1831, and his M.A. in 1837. There being no Natural Sciences Tripos at that time, his degree was an ordinary one. While at Cambridge he attracted the notice of the late Rev. Prof. Henslow, who had just previously exchanged the Professorship of Mineralogy for that of Botany. From the above description of this man's character and attainments, it is sufficiently evident that he was a worthy teacher of a worthy pupil; and the world owes an immense debt of gratitude to him for having been the means of enthusiastically arousing and sagaciously directing the first love and the early study of natural science in the mind of Darwin. No one can be more deeply moved by a sense of this gratitude than was Mr. Darwin himself. His letters, written to Mr. Henslow during his voyage round the world, overflow with feelings of affection, veneration, and obligation to his accomplished master and dearest friend—feelings which throughout his life he retained with undiminished intensity. As he used himself to say, before he knew Prof. Henslow, the only objects of natural history for which he cared were foxes and partridges. But owing to the impulse which he derived from the field excursions of the Henslow class, he became while at Cambridge an ardent collector, especially in the region of entomology; and we remember having heard him observe that the first time he ever saw his own name in print was in connection with the capture of an insect in the fens.

During one of these excursions Prof. Henslow told him that he had been commissioned (through Prof. Peacock) to offer any competent young naturalist the opportunity of accompanying Capt. Fitzroy as a guest on the surveying voyage of the *Beagle*, and that he would strongly urge its acceptance on him. Mr. Darwin had already formed a desire to travel, having been stimulated thereto by reading Humboldt's "Personal Narrative;" so after a short hesitation on the part of his father, who feared that the voyage might "unsettle" him for the Church, the matter was soon decided, and in December of 1831 the expedition started. During the voyage he suffered greatly from sea-sickness, which, together with the fasting and fatigue incidental to long excursions over-land, was probably instrumental in producing the dyspepsia to which, during the remainder of his life, he was a victim. Three years after returning from this voyage of circumnavigation, he married, and in 1842 settled at Down in Kent. The work which afterwards emanated from that quiet and happy English home, which continued up to the day of his death, and which has been more effectual than any other in making the nineteenth century illustrious, will form the subject of our subsequent articles.

(*To be continued.*)

ECLIPSE NOTES[1]

II.

On the present occasion these notes will be more geographical than astronomical, for since the last notes were written, the English Government Eclipse Expedition has traversed through storm and sunshine the distance separating London from Cairo, and is now at the latter place, making final arrangements before it starts to-night up the great river.

The first thing I have to say, is, that the arrangements made for astronomers of all nations by His Highness the Khedive and by his government have been all that could have been desired. Indeed, so universal has been the wish to do everything that could in any way tend to the success of the observations, that it is almost invidious to mention names; but still it is impossible not to recognise that the sympathy for everything scientific which distinguishes Stone Pasha, the chief of the staff, and the important influence which his high position gives him, has done much in kindling the enthusiasm which we find,—an enthusiasm shared in a great degree by the Khedive himself, who has insisted that the astronomers shall be his personal guests during their sojourn on the Nile. But this is to anticipate; it will be better perhaps, in order to give an idea of the thoroughness with which the arrangements have been carried out, to begin at the beginning of our stay in Egypt.

When the *Kaisar-i-Hind* got into harbour at Suez, after a rapid passage through the canal, a passage accelerated at the request of the Egyptian Government, as the canal had been blocked for three days, the Governor of Suez and Ismatt Effendi at once came on board to welcome the party. A special train had been provided with a car for the instruments, which were at once sealed up and guarded after their arrival at the station in Suez Town. Nothing could exceed the kindness of the authorities; the Custom House, which sometimes gives trouble to those who land in Egypt, was never once even thought of, and after spending the night at Suez, a train brought us yesterday to Cairo, his Excellency Stone Pasha himself, with some of his officers detailed for service with the Expedition, being on the platform to welcome the scientific party. The instruments were at once taken to the river-side, where provision had been made to ferry the car containing them, still sealed, across the Nile.

Acting on a suggestion made some time ago, the exact latitude and longitude of Sohag has been absolutely determined; on the old French map its position had been got by rough traverses from Siut. With this new position and a rapid reconnaissance, a new map has been prepared by General Stone, a copy of which I hope to be able to send with these notes. This shows the point at which the line of central eclipse will cross the Nile with no doubt the greatest possible exactitude. In order to prevent any mischance or delay owing to the low Nile interfering with the arrangements, and causing a loss of time, the steamer placed at the disposal of the astronomers by the Egyptian Government is already moored at Sohag, close to the central line, and indeed the French party are already aboard. Communication between Siut and Sohag will be kept up by the Postal steamers, for the Nile is no longer a river of mystery, and a regular postal service is kept up for thousands of miles. But the hotel steamer, as it is called here, will likewise be locomotive. The French party has already erected its instruments to the south of the arm of the Nile shown below Sohag, and in all probability the English party will occupy the high ground shown on the map to the north of Akmim; a position desirable on account of the Khamseen—the terrible dust-laden desert wind—which, however, this year, up to the present moment, has been very merciful; this we may regard as a good or bad presage during the next fortnight, to which its devastating effects are generally confined.

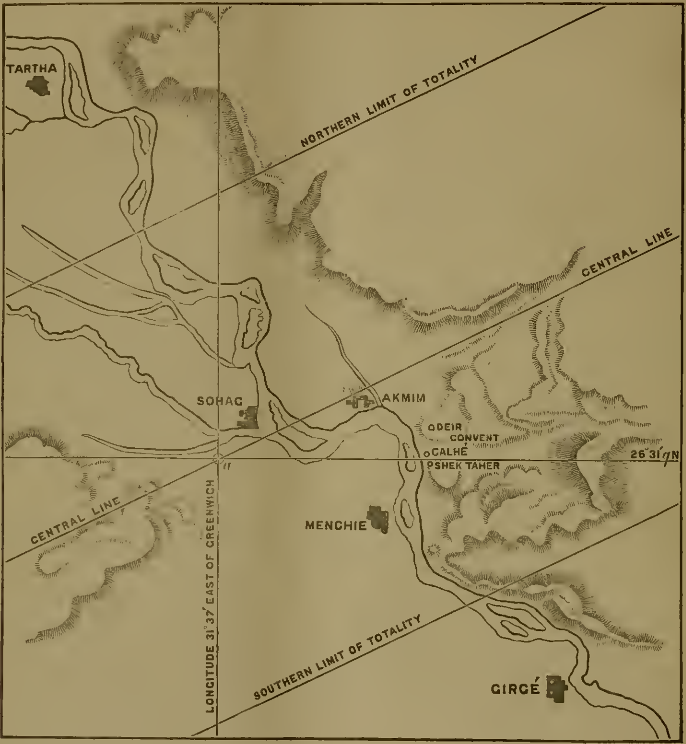
Between these stations the special boat will keep up constant communication.

The Italian Expedition is under the charge of Prof. Tacchini, of Rome, whose long-continued observations of the spectra of prominences are so widely known and

---

[1] Continued from vol. xxv. p. 578.

well appreciated by men of science. He has brought out a small equatorial telescope with spectroscope attached, and it is believed, intends to devote himself exclusively to spectroscopic work during the eclipse. He joins the eclipse boat a few days later on.



The French party consists of MM. Thollon, Trépied Director of the Observatory at Algiers, and M. Buisseux; as above mentioned, they are already at their station; their work will be chiefly spectroscopic.

The Egyptian Government has deputed Moukhtar Bey, Colonel on the Staff, to assist the English party at the place of observation. J. NORMAN LOCKYER

Cairo, May 5

(*To be continued.*)

THE TOTAL ECLIPSE

THE following telegram in the *Times* of to-day from its Special Correspondent with the English expedition to Egypt, gives the following results of the observations of the total solar eclipse of yesterday:—

Sohag, May 17

The total eclipse of the sun was successfully observed here to-day by the English, French, and Italian astronomers.

A fine comet was discovered close to the sun, its position being determined by photographs.

The spectroscopic and eye-observations just before and during the period of totality gave most valuable results, the darkening of the lines observed by the French astronomers indicating a lunar atmosphere.

A series of good photographs of the corona was obtained, and the spectrum of the corona for the first time was successfully photographed.

The astronomers will probably leave on Saturday on board the Government steamer.

THE THEORY OF DESCENT

Studies in the Theory of Descent. By Dr. Aug. Weismann. Translated and Edited by Raphael Meldola, F.C.S. Part III. The Transformation of the Mexican Axolotl into Amblystoma; On the Mechanical Conception of Nature. (London: Sampson Low, Marston, Searle, and Rivington, 1882.)

THE present issue completes the excellent translation of Dr. Weismann's valuable and suggestive work. The first two essays of which it consists is devoted to a careful discussion of the real meaning of the transformation of the Axolotl into Amblystoma. Experiments are detailed showing that the metamorphosis may be induced with much constancy by obliging the Axolotls, at a proper stage of growth, to leave the water, when they lose their gills and undergo a number of other changes constituting a veritable metamorphosis. Dr. Weismann states that many zoologists have expressed an opinion (which was formerly held by himself) that this change is to be considered to be a true advance in development from a species which had hitherto remained in the larval stage, but which, through the influence of certain changed conditions, now advances, *per saltum*, to a higher stage. This view he gives many excellent reasons for considering to be quite erroneous; holding that the facts are best interpreted by supposing that the animal formerly underwent metamorphosis, but that owing to changed conditions it was unable to survive in the perfect state, and therefore remained in the larval condition in which it acquired the power of reproduction.

The causes which led to this change are believed to be a progressive drying up of the Mexican lakes (as long since proved by Humboldt), and a consequent increased aridity of the atmosphere inimical to land amphibia. The axolotl, therefore, presents us with a case of degeneration; and its metamorphosis under changed conditions in confinement is not due to any advance in organisation, but is really a reversion to a not very remote ancestral habit. The whole of the facts at present ascertained with regard to these animals and allied forms in their native habitats, are shown to agree well with this view, which is quite in harmony with the author's explanation of seasonal dimorphism in butterflies, given in Part I. of the same work (see NATURE, vol. xxii. p. 141), and is also more in accordance with the true principles of evolution than the alternative hypothesis.

The second, and concluding essay, is entitled "On the Mechanical Conception of Nature," and is chiefly occupied with an inquiry into the true character of variation as the chief factor in evolution, and into the comparative importance of external conditions, and the constitution of the organism in determining the particular direction of the course of development; the object being to show that all takes place according to fixed laws without the interference of any "teleological principle," whether in the form of a "phyletic vital force" or the interposition of any "designing power." The writers whose views on these subjects are combated are Von Hartmann and Karl Ernst von Baer, and, after an elaborate and often subtle argument, Dr. Weismann concludes that the facts can all be explained on "mechanical" principles, or, as we should say, by the action of fixed laws. He is however careful to add that this does not imply a materialistic view of nature. "Those who defend mechanical development will not be compelled to deny a teleological power, only they would have, with Kant, to think of the latter in the only way in which it can be conceived, viz. *as a Final Cause*." And on the great question of the nature and origin of consciousness he thus expresses himself:—"If it is asked, however, how that which in ourselves and in the remainder of the animal world is *intellectual* and *perceptive*, which *thinks* and *wills*, is ascribable to a mechanical process of development—whether the development of the mind can be conceived as resulting from purely mechanical laws? I answer unhesitatingly in the affirmative with the pure materialist, although I do not agree with him as to the manner in which he derives these phenomena from matter, since thinking and extension are heterogeneous things, and one cannot be considered as a product of the other." And he intimates that the fundamental notion of conscious matter may get us out of the difficulty. However this may be, he maintains that the theory of selection by no means leads—as is always assumed—to the denial of a teleological Universal Cause, and to materialism, but only to the belief that any mode of interference by a directive teleological power, other than by the appointment of the forces producing the phenomena, is, to the naturalist, inadmissible. "The final and main result of this essay will thus be found in the attempted demonstration that the mechanical conception of Nature very well admits of being united with a teleological conception of the Universe."

The work, of which the translation has now been completed by Mr. Meldola, must be considered a very important contribution to the theory of Natural Selection, since it applies that theory to explain in the minutest detail how the more prominent characters of several distinct groups of animals, not obviously useful to them, may have been developed under its action. Such are the distinct markings often occurring in two annual broods of butterflies termed "seasonal dimorphism," the origin of the markings of caterpillars, and the unexpected phenomena of the transformation of the Mexican axolotl; and we are therefore led to conclude that an equally careful and minute study of other cases of difficulty would probably lead to an equally satisfactory explanation. This argument is not, however, conclusive, because the cases here chosen may not be really test cases; and among the countless forms of nature, and especially among the higher animals, there may well be characters or organs the origin of which are due to other and altogether unknown causes. To students of evolution, Dr. Weismann's volume will be both instructive and interesting, but it is a work that requires not merely reading, but study, since its copious facts and elaborate chains of argument are not to be mastered by a hasty perusal. The book is beautifully got up and illustrated by a number of coloured plates admirably executed in chromo-lithography, and it will form a handsome as well as an indispensable addition to every naturalist's library.

ALFRED R. WALLACE

OUR BOOK SHELF

Land and Freshwater Mollusca of India. Edited by Lieut.-Col. H. H. Godwin-Austen, F.R.S., &c. Part I. February, 1882. (London: Taylor and Francis.)

THIS work is announced as "supplementary to Messrs. Theobald and Hanley's 'Conchologia Indica,'" but it is much more than a supplement, and is framed on far more scientific principles. The "Conchologia Indica" was published in 1870; and the editors in their preface say that "after an interval of two or three years it is hoped that materials for a supplement (the malacological portion of which will be edited by Major Godwin-Austen) will be accumulated." The "Conchologia Indica," however, is only what it professed to be—"Illustrations of the Land and Freshwater Shells of British India." The letterpress gives a dry list of species and synonyms, not arranged in classified order, with occasional notes. This is admitted by the editors, who state that they "do not acknowledge the validity of many of these species, but merely illustrate them." They also state their "regret that the figures of some of the more minute shells are not so well executed as they expected; but lithography is scarcely compatible with sharp definition." We fully concur in the last remark. Although this is not a review of their work, we cannot help noticing the fact that certain species of freshwater shells belonging to the northern portion of British India, and which are enumerated in the "Conchologia India," are also natives of Europe. Such are *Limnæa auricularia* and *stagnalis* of Linné, *L. peregra* and *truncatula* of Müller, and *Valvata piscinalis* of Müller; but there is no species of *Unio*, *Anodonta*, *Sphærium*, or *Pisidium* common to the two regions. The occurrence of the first-named five species in countries so geographically and widely separated, may be partly explained by these species having spread from Siberia, which they likewise inhabit; but the mode of their original distribution from Europe to Siberia, or *vice versâ*, still remains a problem. If water-fowl or other animals had been instrumental in such distribution, why should not any of the freshwater bivalves, which are likewise European and Siberian, have been similarly transported to British India?

The present work is intended to be published in parts, of which the first has now appeared. It contains seventeen octavo pages of letterpress and four quarto plates. The descriptions of new species, as regards both the shell and soft parts or animal, have been most carefully written, and the author has properly given the distinctive characters of each species in a correlative order, which is a point of material assistance in comparing one species with another. There are, nevertheless, a few exceptions to this useful rule in species of *Kaliella* and *Microcystina* (pages 5, 12, and 13), where the umbilicus is described first, and before the shape of the shell. The shells are admirably drawn, although the colouring is unsatisfactory. Without having critically studied the specimens figured, and especially "a hatful" of them, one might, on looking at the illustrations, be inclined to question the specific distinction of several. But all naturalists are never likely to agree in that matter; and perhaps it may be immaterial whether certain forms are called species or varieties. The minds of some naturalists have a synthetic and of others an analytic tendency.

Col. Godwin-Austen seems to attach considerable importance to the odontophore or lingual riband as an element of classification. We believe that this affords a good auxiliary character in defining genera or higher groups of the Solenoconchia and Gastropoda; but the recent investigation of the subject by Herr Friele in respect of northern species of *Buccinum* shows that the odontophore varies so greatly in individuals of the same species that it cannot be fully relied on for distinguishing species. Some Gastropods, *e.g.* *Odostomia* and *Eulima*, have no odontophore, in consequence of their food consisting of soft polyparies.

The work now noticed is a very valuable contribution to the natural history of India, and has been intrusted to a naturalist who is by no means less competent because he is actuated by modest aspirations.

J. GWYN JEFFREYS

Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux. 2^{e} série, tome iv. 3^{e} cahier. (Bordeaux, 1881.)

THIS cahier contains nine papers, all mathematical. We recently called attention (vol. xxv. p. 408) to an article in the second cahier, by M. Paul Tannery, on the Arithmetic of the Greeks. The same writer now furnishes two contributions—one, "Sur la mesure du cercle d'Archimède," in which he discusses how far Archimedes (in his κύκλου μέτρησις) was acquainted with methods which form the base of the solution of what is now called the Pellian problem; the second is entitled "De la Solution Géométrique des problèmes du second degré avant Euclide," and in it he discusses questions very nearly allied to those considered by Dr. Allman in his "Greek Geometry from Thales to Euclid."

M. Ordinaire de Lacalouge also contributes two papers—one on the tramways of Bordeaux ("en regardant poser les rails et marcher les premières voitures des tramways on a tout naturellement là l'idée de rechercher le rayon minimum des courbes où ces véhicules peuvent circuler. Ils ont, sous certains rapports, de l'analogie avec les wagons de chemin de fer, mais en diffèrent, surtout par leur vitesse de translation"); the second discusses the "théorie géométrique du pendule de Foucault" as against M. Yvon de Villarceau; it is modestly written, and is valuable from its furnishing many interesting historical references. Regarding the views broached in the article, the author concludes with "le temps dira si c'est une illusion."

M. Kowalski, in a "Note sur les systèmes coordonnés d'unités électriques spécialement sur celui de l'Association Britannique et ses applications," does good work in giving a concise elementary account of these systems of units, "notions que les traités classiques de physique publiées jusqu'ici en France passent à peu près complètement sous silence."

The remaining four papers are by M. Saltel, viz. "Réflexions sur la mesure du volume de la sphère" (with a demonstration); "Étude de la variation du cercle osculateur en un point M d'une section plane d'une surface"; "Théorèmes généraux sur la décomposition des enveloppes, théorème sur les surfaces développables"; "Contribution à la théorie du changement des variables dans le calcul des intégrales simples et multiples."

On and Off Duty: being Leaves from an Officer's Note-Book. By S. P. Oliver. (London: W. H. Allen and Co., 1881.)

THE chief contents of this handsome volume are derived from the rough notes and sketches made by Capt. Oliver, some years ago, when a young subaltern of artillery. They show that, whether in Turania, Lemuria, or Columbia, he took notes of all the strange things he saw, and although many of his observations have appeared from time to time in the journals or proceedings of various societies, or as articles in periodicals, they were, we think, interesting enough to be collected into a more permanent form, which we trust may stimulate others of Her Majesty's officers to follow Capt. Oliver's example.

The first part of the volume is devoted to an account of the author's visit to China and Japan. There is a graphic description of the visit to Tsing-Yuen, to see that the treaty (1860) of peace was properly posted up as required. Snakes are mentioned as abounding; and we learn that snake's flesh is eaten from choice not rarely by the Chinese: indeed, boiled-snake soup is a favourite febrifuge for invalids. The author says that at Shao-K'ing numerous bodies of the rebels were floating past with the stream, and that though the majority were decapitated, all the bodies of the men floated on their backs, whereas all the bodies of the women floated "face downwards." The notes on Japan are of interest, as intercourse with foreigners is so improving the Japanese, that such peculiar games as Jon-noki are not now-a-days to be commonly seen played; and the author was fortunate to see Yeddo ere it ceased to be the exclusive city.

The second part is taken up with a visit to Lemuria, thereby meaning Madagascar and the Mascarene Islands of Bourbon and Mauritius. This visit was made in 1862. The Seychelles were not visited. Some noteworthy details are given of a visit to Madagascar. The home of the *Ouvirandra fenestralis* is well described, and the account of a Mauritius hurricane is true to the life. It is mentioned that in the hurricane of March 12, 1868, the iron girders, 200 feet in length, and weighing over 300 tons, were blown from the railway bridge over Grande Rivière, when a force of 100 pounds to the square foot must have been exerted by the wind down the ravine.

In an appendix to the second part, there is a chapter on the natural history of Madagascar, contributed by Mr. J. G. Baker, F.R.S., of Kew.

The third part of the volume describes a visit to Columbia along with Capt. Pim and Mr. John Collinson, for the promotion of a transit railway route through Mosquitia and Nicaragua.

The volume will commend itself to the general reader, and the scientific notices mentioned therein will be found very generally interesting and correct.

Modern Metrology. By Lowis D'A. Jackson. (London: Crosby Lockwood, 1882.)

It is no easy task to give an account of the various systems of weights and measures in use throughout the world, to trace their origin, and to express their equivalents in English and French weight and measure, but this the author has undertaken in one part of his book, and has brought together much valuable and interesting information. This work is so far a cambist or dictionary of weights and measures, both the scientific and commercial equivalents of all foreign units being given. It would have been well, perhaps, if the author had stated for each country the precise authority from which he obtained his equivalent, as works of this kind should as far as possible contain within themselves means for verifying the accuracy of the figures given.

The main object of the work appears, however, to be the discussion of a remedy for the evils of the complex systems of weights and measures which are unfortunately still in use in this country. To provide such a remedy is a serious task, and one well worthy of the attention of a great statesman such as Mr. Gladstone, to whom this work is inscribed.

The author discusses the vexed question of the relative values of standard temperatures at 32° and at 62°, and proposes a new English system based on a cubic foot of 1000 "fluid ounces," at the temperature of the maximum density of distilled water.

The "fluid ounce" is taken as equal to the weight of distilled water contained in a cubical vessel whose dimensions are equal to a "tithe," or tenth part of the linear foot, when weighed and measured also at the temperature of the maximum density of distilled water. The various parts and multiples of the cubic-foot and "foot-weight" would be built up by decimal progression, so that a strict correspondence would be always maintained between capacity, linear dimension, and weight. The effect of reducing the temperature of the cubic foot from 62° F. (the present legal temperature) to 39°·1 F. (the temperature of the maximum density of water), would bring the weight of the cubic foot more into accordance with modern research, as it would raise its weight from 62·321 lb. to 62·424 lb.

Although we have faint hope of present success in disturbing the deeply-rooted systems of measures now in use by this great commercial nation, or of substituting for the purposes of international science a more acceptable metrology than that based on the metre and gramme, we cannot but recommend this work to the consideration of all interested in the practical reform of our weights and measures.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Sun-Spots and Magnetic Storms

Some particulars of the remarkable double outburst of sun-spots in the latter part of April and of the magnetic disturbances which appear to have been connected with them, as recorded at Greenwich, may be of interest to your readers. It is in itself a noteworthy fact that there should be on the sun at the same time two spots, one of them double, sufficiently large to be visible to the naked eye, and this is made still more interesting by the occurrence of a violent magnetic storm a few days after the appearance of each of these large spots.

The larger of the two spots would seem to have first made its appearance at the east limb on April 11 at about 15h. G.M.T., though no photograph of it was obtained till April 14. It must have passed off the disk about April 25 8h., being well shown on a photograph on April 24. It extended over 10° of heliographic longitude, and measured more than 2′ of arc in length and breadth.

The group preceding it, consisting of two spots, was first photographed near the east limb on April 11, and was then comparatively small. Between April 16 and 17 it increased suddenly in size, becoming nearly as large as the other spot group, and far exceeding in area any of the spots previously recorded at Greenwich.

The areas of these groups on the photographs, expressed in millionths of the sun's visible hemisphere, and corrected for foreshortening were as follows:—

1882.	Great Spot		Preceding Group	
	Nucleus.	Whole Spot.	Nucleus.	Whole Spot.
April 11			17	141
14	351	2218	40	270
16	239	2086	24	156
17	391	1979	204	880
18	465	2030	244	1370
20	340	1916	294	1813
21	427	2105	440	2360
23	267	1786	167	1054
24	316	1727		

The total spotted area on 1882, April 17, was 881 for the nuclei, and 4668 for the whole spots, being about double of the greatest spotted area shown on any of the Greenwich photographs previous to this outburst.

On April 16 and 19 violent magnetic disturbances occurred. At Greenwich the declination, horizontal force, and vertical force magnets became violently disturbed on April 16 at 11h. 30m. G.M.T., the first movement for all three being simultaneous and sudden, and the storm movements continued till April 17, 7h. 30m. G.M.T. The magnets remained quiet till April 19, shortly after 15h. 30m. G.M.T., when another sudden and very sharp disturbance commenced, lasting till April 20, 20h. G.M.T.

In the magnetic storm of April 16-17, there were large oscillations of declination till April 17 0h., the greatest *recorded* motion being about 1°, from a diminished declination at 19h. + to an increased declination at $19\frac{3}{4}$h. Then until 4h. the register cannot be traced, the motions being either unusually rapid, or the magnet being disturbed by workmen in the upper room. About 7h. there were some sharp motions, after which time the magnet became quiet. The principal feature of the disturbance of horizontal force was at first an increase, followed by a much larger diminution, amounting to about 1-50th of the whole force at 16h., when the trace went off the sheet, and was lost until April 17 0h. There was then a great and rapid increase (in about 40m.) of about 1-40th part. Rapid motions were then shown till 7h. 30m. The whole range of these disturbances probably exceeded 1-25th part of the whole force. The vertical force at first decreased somewhat till April 16, 16h., and afterwards very considerably till about 18h., when it was diminished by about 1-100th part, then with the horizontal force it increased till about 1h., when the trace went off the sheet, its value being then greater than the normal by more than 1-100th part. Finally, the normal value was gradually reached again at 7h. 30m.

In the second magnetic storm, the range of the declination movements was 1° 30′, of the horizontal force about 1-50th part of the whole, and of the vertical force about 1·120th part.

Thus the vertical force disturbance on April 19-20 was comparatively small; that of the vertical force on April 16-17 is characteristic of the greatest storms, and since the great disturbances of 1872, February 4, and those of October 4 of the same year, no magnetic storm has been recorded equal to this. Earth-currents were shown throughout both storms.

W. H. M. Christie

Royal Observatory, Greenwich, May 8

Hypothetical High Tides

I regret that I am not able to accept the criticisms of Mr. C. Callaway on my notice of Prof. Ball's lecture. I have studied the effect of tidal and wind waves on many coasts through many years, and my observations do not warrant the statements he makes. Every schoolboy knows the distinction between waves of undulation and translation, and it is in no sense true that I have confused them. With waves of undulation such as occur in mid ocean we have nothing to do in this discussion, but it cannot be unknown to Mr. Callaway that all such waves when reaching a shore, become waves of translation, and more or less powerful denuding agents. If he will have the kindness to refer to my "Report on the Geology of Ohio," vol. i. pp. 52, &c., he will find that I have done ample justice to the efficiency of wind waves as agents of geological change. The great tidal current rushing arouud the earth, with which he credits me, exists only in his own imagination. I have suggested nothing of the kind, but the rapid ebb and flow over the shores of continents of tidal waves several hundred feet in height must necessarily act with great violence upon such shores, and I insist that such tidal waves as pictured by Prof. Ball would have left a very different record from that we find in our Palæozoic rocks. Some of our American Silurian strata were deposited on shores that faced toward the east, where they had an unbroken stretch of several thousands of miles of ocean over which the tidal wave would come to them without obstruction, and there the maximum effect of such tides as Prof. Ball describes would be produced, but no traces of them are found.

I am aware that the reef-building corals of the Devonian were zoologically distinct from any now living, and for that reason conditioned my inference from them; but we have satisfactory evidence that the Devonian coral reefs of Ohio and Kentucky were formed *along a shore* and in a *warm* sea, like the reef-building corals of the present day, and there are many reasons for believing that their mode of life was the same.

The point made by Mr. Searles Wood in regard to the coal, though objected to by Mr. Callaway, is well taken, for we know that the great coal marshes of America were located just at the sea level, and from time to time were inundated by the sea and covered with sheets of *marine* limestone. It requires no argument to show that the growth of the Carboniferous forests and the formation of beds of peat—now coal—could not have taken place with tides rising one-half or even one-fourth of the height of those described by Prof. Ball.

On carefully reviewing the facts which suggested my objection to Prof. Ball's theory, I am compelled to reiterate the statement before made, that on the east coast of North America the geological record bears positive and conclusive testimony against the high tide theory, and that at least since the Archæan ages no tides have swept this coast like those required by Prof. Ball's theory, even as modified by Mr. Darwin.

New York, April 10 J. S. Newberry

Aurora Borealis

A polar aurora of remarkable activity and brilliancy was observable here at 11.15 last night. The centre of energy at the time of origin was under Cassiopiea, a highly luminous streamer shooting upwards from the horizon, and covering, but not hiding the stars in that constellation. Brilliant white flickering streamers and rays, arising from the horizon, quickly spread towards the north-west, and an irregular shaped mass of crimson light, of an altitude of 45°, and many degrees in breadth, appeared, and suffused the northern hemisphere from Cassiopiea to Gemini. Between the horizon and the mass of crimson-coloured vapour the sky was of a light green hue, and upwards, through this area of greenish light, the rays and streamers shot.

During the period of greatest energy, a beam of vivid light arose towards the north-west, was projected over Gemini, and quite extinguished the light of the two large stars in that constellation. About midnight the meteor faded. Soon afterwards the sky became overcast. Throughout the day the wind had been blowing briskly and coldly from a point in the north-east. Barometer, highest during the day in the shade, 60; aneroid, 30·2. In the afternoon, curious slender-rayed cirri from the north-west, generally indicative to my mind of auroral disturbanie, crossed the northern sky towards the zenith. To-day, detached clouds and blue sky, and the wind is blowing stiffly and icily from the same point. Barometer and aneroid same as yesterday, the latter inclined to full.

An auroral display of the like splendour and activity is very rare, if not wholly unknown in this locality at this time of the year. X.

Worcester, May 15

At 10·55 p.m. last night, I observed a very beautiful aurora borealis, consisting mainly of three beams, nearly vertical, and then parallel to the direction of the stars α and δ of the Great Bear. They moved slowly towards the east, and about 11·5 faded away. About 11 o'clock they were very brilliant, and the central beam, then quite close to the Polar star presented a slightly purple or violet colour, as represented in the sketch inclosed. Near the earth, and at about 15° to 20° elevation, there was a mass or cloud of suffused light, from which the beams seemed to rise. It seems that an aurora was also seen about a fortnight ago from Dublin. The wind has been easterly, and to-day is somewhat colder than yesterday.

J. P. O'Reilly

Royal College of Science, Dublin, May 14

Spectrum of Wells' Comet

The continuous spectrum of this comet, especially of the nucleus, is remarkably bright. I observed it on April 18 and May 6 and 15. There were at least three bright bands, and perhaps more. I believe the usual three were visible, but they were so indistinct that I did not observe their positions. The middle one was much the brightest, and the only one plainly visible. I never saw a comet in which the bright bands were so faint, relative to the continuous spectrum.

May 16 T. W. Backhouse

The Recent Violent Storm

May I ask your permission to insert from me a curious circumstance, which came under my notice, soon after the tremendous storm which took place on Saturday, April 29 last. On the glass of some of the windows of the house in which I reside I perceived a very singular appearance upon them, somewhat resembling a deposit from milk. On looking at it through a microscope I discovered a number of very beautiful crystals, which, without doubt, were caused by the spray from the sea, as on applying it to the tongue, there was a strong taste of salt. The distance the spray must have been carried on this occasion could not have been less than sixty miles, taking into consideration the course of the wind, which was south-west.

Nathaniel Waterall

Waddon, Croydon, Surrey, May 15

The Cuckoo

Is it a normal habit, or only an erratic freak of that quaint bird, the cuckoo, to sing at night. On the night of Monday, the 8th inst., I first heard, at 10 p.m., three or four calls, but took little notice of it, thinking the bird had been startled from his dreams, but in a short time he recommenced, and went on continuously with short intervals of silence, until 12 or 1, precisely as by day.

It was a dark night with only dim starlight. I should like to know whether others have remarked this nocturnal loquacity in the cuckoo. This particular bird has usually commenced his song or call at about 4 a.m. J. E. A. Brown

May 11

The Swedish Fisheries

In Nature of April 20 you ask for an explanation of the difference in the figures of Dr. Oscar Dickson and Dr. Lundberg relating to the Swedish fisheries.

1. You mention that Dr. Lundberg, in the "Notizen uber die Schwedischen Fischereien," 1880, valued the herring fisheries of Sweden at 5,000,000 marks (3,547,303, p. 27), but you forget that Lundberg's book only refers to the "Ostsee und Sussvasser Fischereien," and Dr. Dickson only speaks of the west coast or North Sea fisheries.

2. About the "millions of barrels representing millions of pounds sterling," the Swedish North Sea Herring Fisheries statistics value the barrel herring *now* only at 1 to 2 shillings in the first (fisherman's) hands. And you will notice that the millions of barrels mentioned by Dr. Oscar Dickson in the *Scotsman*, refer to a former period, nearly a century ago, not to the present period, commenced 1877.

Pyphis, Sweden, May 3 Gerhard von Yhlez

THE OLDEST EGYPTIAN TOMBS AND TENANTS

ALTHOUGH the existence of mankind in the dawn of civilisation at the Stone age, and using Palæolithic tools is distinctly proved in Northern Africa and Algeria, the specimens discovered on the soil of Egypt are not so unequivocally Palæolithic, although those published by Sir J. Lubbock approach the type. Of the Neolithic stone weapons, numerous examples have been found, some undoubtedly in use at the time of the eleventh and twelfth dynasty, others probably descending to the eighteenth and nineteenth dynasties. The indications, however, of sepulchres of the Palæolithic period are absolutely wanting on the soil of Egypt, and except the stone huts in the Arabian Peninsula, belonging to the more ancient period, there are no remains of contemporary construction.

In the graves around the oldest pyramids Neolithic remains are occasionally found, and there can be no doubt that flint weapons were extensively used at the oldest pyramidal period, which, however, was one of copper and bronze, copper and even iron objects having been found in the air passages of the great Pyramid, and indications of the use of the hollow bronze drill in the stone sarcophagi of the same epoch. The pyramids were arranged chequer-wise in groups, and each separate site belonged to a different dynasty, the kings and other royal personages being inhumed in them, while around the pyramid of each site were arranged the tombs of the courtiers and officers of the court. The arrangement of these tombs differs at the respective sites. At Sakkarah they are arranged in rectangular groups of streets, and the same arrangement prevails at Gizeh. At Abusir the last undulations of the step-shaped hills which crown the pyramids are occupied by some tombs scattered about of the time of the fourth and fifth dynasty. At Dashour there are also some tombs of a very early and unknown period, and at Meidum, tombs of the third dynasty. All these tombs bear a general resemblance to each other, and pass by the general Arab name of *mastabas*, "counters," or "beds." At first sight they look like the pedestals of pyramids, or truncated pyramids, being of rectangular shape, with sloping sides; they are, however, not square, but rectangular, and the angle of the sides is so great that the walls, if produced upwards, would rise to 600 feet, an impossible height for such a construction. Consequently they are not of the class of pyramids, but only show the Egyptian preference for converging lines, instead of purely parallel or rectangular forms; the short sides also in some instances are step-shaped, the layers of stone are squared and laid in horizontal courses, and not polygonal masses. These rectangular masses of masonry or brick-work, the details of which will be subsequently described, did not contain the sepulchral chamber, for that is always found in the solid rock beneath, the access to which was by a rectangular shaft or well, down which the coffin and mummy were lowered by ropes; the mass of masonry above had only in it the sepulchral chamber and the cell for the sepulchral statue. The general "cemetery," with its street of tombs, was called in Egyptian *kher* or *khel;* the individual tombs bore the general name of *maha* "sepulchres," which was applicable to any class of tomb, whether those of the kings or used by the inhabitants of the town or city. The term *mer* was applied to any tombs which had pyramidal construction, as those made of brick with pyramidal tops cut out of the flank of the hill at the time of the eleventh dynasty at the Drah Abu'-l Neggah, in the western quarter of Thebes; but the term applied to the syringes or hollowed passages and tunnelled tombs at Gournah and elsewhere is *asi*, a word applied to a plant, perhaps a "reed," but also meaning a chamber, and this word was used to express the so-called mastaba, or quadrilateral sepulchre of the early dynasties. The great necropolis of Sakkarah is supposed to be that of the ancient Ka-Kam, the city of the Black Bull, known to the Greeks under the name of Cochome, and the pyramid there to have been named *Ap*, the "elevation" or "Mount," and the pyramid was step-shaped, made of unbaked brick, probably when first built in seven stages.

The mastabas were the mausolea of the richer and more important personages of the court hierarchy and Egyptian bureaucracy, for the poor and slaves were not buried with any consideration; they were hustled into superficial graves about three feet deep beneath the soil, and at this distant period of time are found only as skeletons, with no linen wraps remaining or other traces of emblems, and must therefore be regarded as the oldest and most primitive examples of Egyptian interment, and their bodies were unprovided with coffins. Occasionally, perhaps, some of the least poor, or slaves of extraordinary merit, had rectangular vaulted chambers, constructed of brick-work, vaulted and covered with a white coating; in the interior of these rude graves are found small vases or cups of coarse pottery or calcareous stone or alabaster, but uninscribed. These graves recal to mind those of the later Roman period, although the Memphian ones belong to a period long anterior.

The mastabas vary in size and dimension, but their average or normal dimensions are nearly fifty yards long, twelve yards wide, and thirty deep. The chief of these mastabas is the Mastabat-il-Pharaoun, which recent discoveries show to have been the sepulchre of Unas of the fifth dynasty, who was not buried in a pyramid. The mastabas are said to be peculiar to Gizeh, and not to be found elsewhere, and a long interval of civilisation must have preceded the construction of these tombs, as they show a considerable knowledge of architecture by their regular and geometric construction, while the square blocks and regular layers, each vertical joint being overlapped by a square stone, evidence considerable technical experience in the art of masonry. The other mastabas are made of similar masses of brick-work, and the bricks are of two kinds, those of the oldest mastabas, made of rectangular yellow bricks, composed of sand, pebbles, and some Nile mud, their dimensions being 22×11×7 of a metre, and black bricks made of alluvial soil and straw, larger in size, being 38×18×14 of a metre; these bricks are not older than the middle of the fourth dynasty, while the others are as old as the second line. The black bricks continue till the time of the Romans, and both kinds are sun-dried, no burnt bricks, with the exception of the conical stamped bricks, found at the tombs of the Drah-Ahi' l'Neggah, having been employed in constructions till the age of the Cæsars.

In the masses of brick-work or masonry which stood above the soil over the sepulchral chamber, hewn out of the solid rocks beneath, were constructed the mortuary chapel, for the performance of masses or liturgies to the dead, which, however, must have been of a simpler nature than those in use at a later period. In all these mastabas which, as a rule, face northwards, generally towards the north-east angle, is a kind of stele or sepulchral tablet of limestone, some times like facade, composed of separate pieces, and having two square pillars or columns in front, without capitals or abaci, forming a kind of entrance hall. This part of the mastaba is rarely on the south, never on the west, and the ceiling is always continuous, sometimes slightly vaulted by the stones supporting one another. The tablet is often like a door, with jambs, lintels, and hieroglyphics; sometime the facade or stele has a kind of false door with large figures of the occupant of the tomb and his wife at the sides of the false door, with a semicylindrical tambour above the door and a kind of cornice above that, with a sepulchral dedication to Anubis, never to Osiris, and representations of the person for whom the sepulchre was made, at a repast or some other diversion, as the fowling represented on the mastaba at Meidum. On the portion of the soil covering the serdab or inner niche and the well by which the sarcophagus and its mummy were lowered, are found little vases filled with a coating containing inside the trace of the water with which they were filled. The interior chapel or *asi* was either single, or had more than one chamber, and the walls of these were covered with pictures and inscriptions engraved in intaglio and brightly coloured, still vivid after 6000 years, but no furniture itself or offerings are discovered in the rooms, which have been long open to the spoiler. The inscriptions refer to the calendar and festivals throughout the year, the titles of the deceased, adoration to Anubis, and tables of food, or *menus* in use at the period; and the gourmands of the Egyptian aristocracy fared sumptuously every day out of well-filled flesh-pots and jars of wine and beer. The paintings on the walls depict the chase, the farm, the industrial household, the amusement of dances by professional women, games, and other diversions, and were no doubt intended to recal to the spirit of the dead his favourite occupations and his former wealth. Such solaces were reserved for the rich; the poor reposed after death about as indifferently as during life.

When constructed of masonry, the walls of the chapel in the mastaba were often made of rubble revetted, and at the end, at the foot of the false door is often found the stone altar of libations, sometimes with two small obelisks engraved only on one face; at other times, instead of obelisks, two supports in the shape of altars. The stele or sepulchral tablet was at the earliest period made in shape of a facade, but often quite blank, a mere white slab. It is not till after the sixth dynasty that these tombstones were rounded at the top, like those of the present day. When the chapel was ornamented, the tombstones are often blank; when the walls of the chapel—the *asi* —were unadorned, the tablets were often inscribed. In the most ancient tombs the tombstones are often built up of pieces and are inscribed with hieroglyphics of an early and rude type. The art is bad, and the inscriptions are not in regular lines, but dispersed over the area; the hieroglyphics themselves are often peculiar, executed with more elaborate detail than at the later period of the middle Empire. The object of these early inscriptions is to record the name and titles of the departed, and it is remarkable that at this period persons had the *ran āā*, or "great name," and the *ran-nets*, or "little name." A tomb, for example, of the second dynasty, at Sakkarah, was made for a man whose great name was Sekarkhabau, or "Sochari's rising amongst spirits," whose small name was Hothes—that of a rat or some small animal; and his wife's great name was Atherhotep, and her little name Teps; and this as early as the second dynasty. These chapels now have no doors, if they ever had, and except the vases found strewed here and there on the floor, the other objects which may have been deposited there have entirely disappeared. Behind the wall, on the south side more often than the north, and on the north more often than the west, was a secret niche, which the Arabs call the *serdab*, occasionally communicating with the chamber by a square orifice. In this niche was deposited a statue of the deceased. In this statue was supposed to reside his *ka*, or spirit, a kind of manes, or ghost, which inhabited the tomb, went in and out of the sepulchre and Hades, and to which was attached a priest, who performed the liturgies or litanies, in certain ways, and with peculiar rites. In the earlier inscriptions this ka is not mentioned, but at the close of the twelfth dynasty, all the benefits conferred by deities on the deceased were said to be due to his *ka*. It was in this chapel and to this image that the ancestral worship was paid, and the *ka*, which was a kind of *idolon* of the dead, was supposed to receive the same satisfaction as the dead himself. Most of the statues in the museums of Europe at the time of the fourth and sixth dynasties, came from the serdab of the sepulchre of the period. They were portraits of the dead, and sometimes represented him holding the tools or other marks of his profession. The whole of the mastaba, or chapel, and its mass was superposed on the real sepulchral chamber beneath, which it covered. The descent to this was by a rectangular well or shaft, from six feet six inches, to nearly ten feet square, and this cell passed through the masonry or platform of the mastaba, and then through the living roots of the foundation, and was made of large blocks; it was down this well that the sarcophagus was lowered to the chamber, by a shaft from thirty to seventy-five feet deep. Hence, at the base of the shaft, a short passage led to the rectangular chamber, which was well built, but has only once been found uncemented, and in it was placed the sarcophagus of granite, or calcareous stone, and the mummy, or body. The cell itself was carefully blocked up with rubbish to prevent access to the chamber, and the mouth of it is generally found either in the long axis of the tomb, or else behind the tombstone. The sarcophagus of this period has no resemblance to the later cases in shape of the human form, generally made of wood, which prevailed from the eleventh dynasty, or about 1800 B.C., to the first century, A.D., but are rectangular chests with vaulted cover, with projections at the edges. The bodies found in these chests are distinguished by the absence of linen or wraps in which they may have been embalmed, and bones of the skeleton are only discovered generally, of a brown colour, with a faint odour of bitumen, which is the more remarkable as the mummies found in the pyramid had both linen and indications of bitumen.

Of course, the ethnological question here arises, to what race of men did these old Egyptians of the period of the second and subsequent dynasties belong; they have been referred to the Caucasian races, and some of the skulls show a high intellectual development, even frontal sutures occurring. Their colour is painted in the sculptures, and on their statues, either red or copper, the female yellow, but their profile is not Semitic, and shows, as at the period of their history, traces of African blood. Some of the servants are dolicocephalic, and are supposed to be the indigenous race, similar to the Libyans of Northern Africa, who, however, at a later period, are classed amongst the white races.

It is, however, in vain to look for the origin of Egyptian civilisation, either in Aethiopia or Nubia, or south of Egypt, or on the northern coast of Africa, which lies to the west, for there is no evidence of races in these parts having ever attained a nascent civilisation, such as the Egyptian might have started from. Recent discoveries in Southern Mesopotamia, however, show a similar civilisation, almost, if not as old as the Egyptian, with a form of written language developing from the ideographic to that of the conventional type, into which the original picture invariably declines. The physical type, too, of the Babylonian statues from Tel-lo, approaches the Caucasian rather than the Semitic type.

ON SOME RECENT AMERICAN MATHEMATICAL TEXT-BOOKS

In Nature (vol. xvi. p. 21) we drew attention to a "shaking" that was taking place among the "dry bones" of the mathematical text-books in common use in American colleges and schools, and upon the analysis we then furnished of a few works before us we ventured to predict a speedy awakening of mathematical life. Our prognostications have been quickly fulfilled, and we now propose to submit an account of five recent books, some of which are quite fitted to hold their own, in our opinion, with English text-books on the same subjects.

"The Elements of the Integral Calculus, with a Key to the Solution of Differential Equations," by Dr. W. E. Byerly (Boston, 1881), is a sequel to the volume on the "Differential Calculus," previously noticed by us. This work is founded upon Bertrand's classical treatise, supplemented by free use of the allied treatises by Todhunter, Boole, and Benjamin Peirce. The opening chapters give a clear exposition of the use of symbols of operation and of imaginaries. So early an introduction to these subjects is novel to us in this connection, but it shows how the subject of quaternions is coming to the front, and the passage from the subjects of these chapters to quaternions is but a short one The main portion of the book calls for no special comment. In Chapter XIV. we have a treatment of *mean value and probability*, founded upon the able contributions of Prof. M. W. Crofton, F.R.S., to Mr. Williamson's treatise.

The novelty of the book is Chapter XV., entitled "Key to the Solution of Differential Equations." This key is based upon Boole's work, and is a collection of concise, practical rules for the solution of these equations. An idea of its form will be best conveyed to some persons by saying that it resembles the analytical key so frequently prefixed now-a-days to handbooks of the British (and other) flora. By a series of references we run the particular equation to ground. Thus, taking the example, $(1+x)ydx+(1-y)xdy=0$, it is a single equation, this sends us to a number; it involves ordinary derivatives, this advances us a stage; it contains two variables, is of the first order, and finally of the first degree. The upshot is we arrive at the form $Xdx+Ydy=0$, under which head we learn how to solve the equation. Under this last head, as throughout the book, are given numerous illustrative exercises for practice.

Dr. A. S. Hardy's "Elements of Quaternions" (Boston, 1881) is intended to meet the wants of beginners. In addition to the works of Sir William R. Hamilton and Prof. Tait, the author has consulted the memoirs or works of Bellavitis ("Calcolo dei Quaternione" and the "Exposition de la Méthode des Équipollences" in Laisant's translation); Hoüel's "Quantités Complexes;" Argand's "Essai" (1806); Laisant's "Applications mécaniques du Calcul des Quaternions," and one or two other books and papers in the *American Journal of Mathematics*, vol. i. p. 379. It is a good introduction to such a work as Prof. Tait's, the originality and conciseness of which, however, Dr. Hardy thinks to be "beyond the time and need of the beginner."

Our next book is "An Elementary Treatise on Mensuration," by G. B. Halsted (Boston, 1881). Dr. Halsted is already known to mathematicians here as the author of a very full "Bibliography of Hyper-space and non-Euclidean Geometry," in the *American Journal of Mathematics*, vol. i., Nos. 3, 4. This treatise on Metrical Geometry is "the outcome of work on the subject while teaching it to large classes," so that it is no hastily prepared book, but has been founded on actual teaching experience. The methods have a German "smell," and this is justified by the author's residence, we presume as a student, at Berlin. There are eight chapters: (1) on the measurement of lines (triangles, method of limits, rectification of the circle; (2) on the measurement of angles; (3) of plane areas; (4) of surfaces (he uses *Mantel* for lateral surfaces, also *Steregon* and *Steradian* in connection with a solid angle); (5) of volumes (*Quader* is new for De Morgan's "right solid"). In these last two chapters the solids discussed are the prism, cylinder, pyramid, cone, and sphere; an article is also devoted to Pappus's theorem. (6) The applicability of the prismoidal formula; (7) approximative methods, as Weddle's method; (8) on the mass-centre, with a paragraph on the mass-centre of an octahedron, which gives Clifford's construction (see *Proc.* Lond. Math. Soc., vol. ix. p. 28). There are numerous exercises, these we have not tested. The book is most effectively "got up," the printing, figures, and paper being, to our mind, excellent.

Our last two books are by Prof. Simon Newcomb, so well known as the author of "Popular Astronomy." The first, "Algebra for Schools and Colleges" (New York, 1881), has already reached its second edition. It is a capital book; indeed we are disposed to rank it as the best manual on the subject that we have seen for school purposes. It is divided into two portions, "the first adapted to well-prepared beginners, and comprising about what is commonly required for admission to colleges, and the second designed for the more advanced general student." We shall perhaps best serve the end we have in view in noticing this work by giving an analysis of the author's preface. The principles of construction are (1) that an idea cannot be fully grasped by the youthful mind unless it is presented in a concrete form. Hence numerical examples of nearly all algebraic operations and theorems are given—so numbers are preferred to literal symbols in many cases. The relations of positive and negative algebraic quantities are represented by lines and directions at the very earliest stage. "Should it appear to any one that we thus detract from the generality of algebraic quantities, it is sufficient to reply that the system is the same which mathematicians use to assist their conceptions of advanced algebra, and without which they would never have been able to grasp the complicated relations of imaginary quantities." Principle (2) is that all mathematical conceptions require time to become engrafted upon the mind, and the longer, the abstruser they are. "It is from a failure to take account of this fact, rather than from any inherent defect in the minds of our youth, that we are to attribute the backward state of mathematical instruction in this country, as compared with the continent of Europe." Prof. Newcomb considers the true method of meeting this difficulty is to adopt the French and German plan of teaching algebra in a broader way, and of introducing the more advanced conceptions at the earliest practicable period in the course. A third feature is the minute subdivision of each subject, and the exercising the pupil on the details before combining them inta a whole. This remark especially applies to the solution of the exercises. Some subjects have been omitted (as G.C.D. of polynomials, square roots of binomial surds, and Sturm's theorem), as they have no application "in the usual course of mathematical study, nor advance the student's conception of algebra," and in studying them there is a waste of power. "Thoroughness" has been our author's aim rather than "multiplicity of subjects." There are other points of interest in this preface which show that the writer is a very experienced teacher, and which we commend to the consideration of teachers here, but we must pass on to indicate the contents of the two parts.

Part I. embraces algebraic language and operations, equations, ratios and proportion, powers and roots, equations (quadratic), progressions, seven books in all.

Part II. treats of relations between algebraic quantities (functions, &c.), the theory of numbers (also continued fractions), the combinatory analysis (including probabilities), series and the doctrine of limits, imaginary quantities (operations with the imaginary unit and the geometrical representation of imaginary quantities: note our remarks above on this head under Byerly), the general theory of equations.

The second of Prof. Newcomb's works before us is "Elements of Geometry" (New York, 1881). An article in our columns (NATURE, vol. xxi. p. 293), headed "The Fundamental Definitions and Propositions of Geometry, with especial Reference to the 'Syllabus' of the Association for the Improvement of Geometrical Teaching," gives its readers a hint that some such work as the one before us was even then in the author's mind—"A summary of my own, the latter [*i.e.* the summary] still in an inchoate state." The remarks in this article showed that their writer was well fitted to address himself to the subject of a geometrical text-book, and the execution is not at all inferior to the promise. The ground taken up is the Euclidian geometry as comprised in the treatises of Euclid himself, Legendre, and Chauvenet. As with the "Algebra," here let Prof. Newcomb speak for himself. As he himself says, the question of the best form of development is one of great interest at the present time among both teachers and thinkers. The object not being to teach geometry merely, but the general training of the powers of thought and expression being a main object, Prof. Newcomb considers it most important to guard against habits of loose thought and incomplete expression to which the pupil is prone. This he considers is best secured by teaching the subject on the old lines. The defects he finds in Euclid's system are (1) in the treatment of angular magnitude; here he makes two additions, the explicit definition of the angle which is equal to the sum of two right angles, and the recognition of the sum of two right angles as itself an angle. He adopts, from the "Syllabus," the term "straight angle," though he himself inclined (NATURE, *loc. cit.*) to the use of "flat angle," and considers the German "gestreckte Winkel" to be more expressive. Then (2) the restriction of the definition of plane figures to portions of a plane surface. "In modern geometry figures are considered from a much more general point of view as forms of any kind, whether made up of points, lines, surfaces, or solids." In an appendix, "Notes on the Fundamental Concepts of Geometry" he returns to a consideration of this subject.

Features of the book are (1) the practising the student in the analysis of geometrical relations by means of the eye before instructing him in formal demonstrations; (2) the application of the symmetric properties of figures in demonstrating the fundamental theorem of parallels (*cf.* German methods and Henrici's conguent figures); (3) the analysis of the problems of construction, to lead the pupil to discover the construction himself by reasoning; (4) the division of each demonstration into separate numbered steps, and the statement of each conclusion, where practicable, as a relation between magnitudes; (5) the theorems for exercise have been selected with a view to interesting the student in the study, and the author has endeavoured to graduate them in order of difficulty; (6) some of the first principles of conic sections have been unfolded, more especially for the use of students who do not propose to study analytical treatises on those curves; (7) Euclid's treatment of proportion is "perfectly rigorous, but has the great disadvantages of intolerable prolixity, unfamiliar conceptions, and the non-use of numbers. The system common in American works of treating the subject merely as the algebra of fractions, has the advantage of ease and simplicity." But to this last system there are obvious objections, and our author essays with some reserve, a *via media*. In this part and in the following Prof. Newcomb submits his methods to the judgment of teachers. Feature (8) involves the treatment of the fundamental relations of lines and planes in space. "In presenting it he has been led to follow more closely the line of thought in Euclid than that in modern works. At the same time he is not fully satisfied with his treatment, and conceives that improvements are yet to be made."

It will be gathered that the book covers most of the ground passed over by young students in plane and solid geometry, and conics in their school training. We cordially commend both Prof. Newcomb's works to teachers in this country, and we feel sure they will not regret our having called their attention to them so fully in the author's own words, as they will thus see in what way his books are likely to be helpful to them. We have read them with much interest, and feel sure our readers will endorse our favourable verdict upon them. We need only say that the author considers that the study of geometry as here unfolded can be advantageously commenced at the age of twelve or thirteen years. The volumes, with a third, which we have not seen, on Astronomy, form part of "Newcomb's Mathematical Course."

R. TUCKER

ELECTRICITY AT THE CRYSTAL PALACE

IV.—*Submarine Telegraphy*

IN the stall of the South Eastern Railway Company at the Crystal Palace may be seen a specimen of the first cable core ever submerged. It consists of a slender copper wire coated with gutta-percha, and was prepared at Streatham by Mr. J. Forster. On January 10, 1849, it was submerged by Mr. Walker, at Folkestone, and a copy of the telegram announcing the completion of the work is still preserved. It runs: "I am on board the *Princess Clementine*. I am successful; 12.49 p.m." Next year a cable was laid between Dover and Cape Grisnez by Mr. Wollaston, but lasted only a few hours. Several specimens of it are shown in the Exhibition by the South Eastern Railway Company and the Post Office. The gutta-percha core was quite unprotected, and it was sunk by means of lead weights attached at intervals. Next year a core, protected by hemp and iron sheathing, was laid by Mr. T. R. Crampton between Dover and Cape Grisnez, and proved so successful, that it is still working. Specimens of this cable, which has proved the type of all subsequent ones, are also to be seen.

There are now some 97,200 miles of cable at work in the world, and before this year is ended the hundred thousand miles will have been attained; for the second Jay Gould Atlantic cable is still unfinished, and the s.s. *Silvertown* of the India-rubber and Gutta-percha Telegraph Company is now on her way to lay some two thousand miles on the West Coast of Central America. Nearly all this cable has been made in London, and the Telegraph Construction and Maintenance Company alone has manufactured 65,400 miles, and laid it in almost every sea, in depths varying from shoal water to 3000 fathoms. In 1863 the firm was resolved into the existing Company. Specimens of all the cables made by them are exhibited in a large glass case, together with a large map of the world, showing all the submarine and land lines in existence; those constructed by the Company being marked in red. The most novel feature of their exhibit is, however, a plan for keeping up telegraphic communication between a lightship and the shore. In 1870 an attempt was made to establish a floating telegraph station in the chops of the Channel; an old man-of-war corvette, the *Brisk*, being fitted up, and moored in deep water about sixty miles from the Land's End. It was found, however, that as the ship swung with the tide, the telegraph cable fouled with the ship's riding-chain, and likewise became twisted into kinks, which crushed the gutta-percha core and destroyed the insulation of the cable. Means were taken to prevent this trouble, but as passing ships did not leave a sufficient number of telegrams, the project was abandoned. Nevertheless, it is clear that such a scheme is worthy of further trial; and even with ordinary lightships it is eminently desirable that they should be in telegraphic communication with the nearest Coast Guard Station. At present, guns and rockets are the only available messengers, and when the wind is off the shore, guns are sometimes not heard; or when the weather is thick, rockets are not seen. The result is, that ships are sometimes lost on shoals close by the lightships, without the Lifeboat Station knowing it. Carrier-pigeons have been tried, but these birds fail to make good progress in snow-storms or thick weather, and in heavy gales are driven hither and thither at the mercy of the elements. The plan for cable communication adopted by the Telegraph Construction and Maintenance Company is to moor the lightships by chains to two mushroom anchors sunk a considerable distance apart. One of these chains is made double, and the cable runs through the middle of it between the double links, as shown in Fig. 1. The chains meet at a mooring swivel. which is made so as to allow the cable to pass through it, as shown in Fig. 2. Between the swivel and the bow sheave of the ship, a revolving joint in the cable, designed by Mr. Lucas, prevents the cable becoming twisted as the ship swings to the wind and tides. A sufficient length of cable is coiled in a tank on board, for paying out, when from stress of weather it is necessary to employ more chain. A pretty model of a lightship moored on this plan is exhibited by the Company, and on touching a press-button let into the edge of the tank, an electric current is sent through the communicating cable, and strikes a bell on board the ship. It is satisfactory to know that the Trinity House have agreed to test the plan by means of a cable between the *Sunk* lightship moored some eight miles off the Essex coast, and the Post Office of Walton-on-the-Naze, from whence telegrams can be sent by day or night for any assistance required.

Of the total 97,200 miles of cable in the world, some 36,420 are owned and worked by the Eastern Telegraph Company and its affiliated companies the Eastern Extension Telegraph Company and the South African Telegraph Company. The Eastern Telegraph Company is perhaps the most enterprising of cable corporations, and makes a very fine display at the Crystal Palace. Cable operations have been of great assistance to the geographer, and the soundings taken in order to ascertain the nature of the sea-bottom, where a cable route is projected, have enriched our charts quite as much as special voyages. There is, however, another way in which these operations could be made subservient to the cause of natural science; but it is a way which has not been sufficiently taken advantage of. Besides the specimens of stones, mud, and sand, which the sounding-lead brings up from the deep, the cable itself, when hauled up for repairs, after a period of submergence, is frequently swarming with the live inhabitants of the sea-floor—crabs, corals, snakes, molluscs, and fifty other species—as well as overgrown with the weeds and mosses of the bottom. Some attempt was made to describe these captures of the wire, as taken from the tepid seas of the Amazon mouth, by the writer in our pages several years ago (vol. xi. p. 329),[1] and the suggestion was there made that cable repairing might serve as a novel method of dredging; but the hint has probably not been taken, for we cannot learn of any competent naturalist having taken his passage on board a cable-repairing ship, say in the Brazilian and West Indian waters, or better still, the East Indian waters traversed, by the lines of the Eastern and Eastern Extension Telegraph Company, from Aden to Bombay, and from Madras to Penang, Singapore, Batavia, and soon to Port Darwin, in Australia. The result is that cables have again and again been lifted richly vestured with the spoils of the bottom, and many an unknown species has passed over the drums unnoted, to rot and fester in the general mess within the cable tanks. We venture to predict a rare harvest to the first naturalist who will accompany a repairing ship, and provide himself with means to bottle up the specimens which cling to the cable as it is pulled up from the sea.

Some idea of these trophies may be gathered from the stall of the Eastern Telegraph Company, where a few of them are preserved. Two of these are a very fine grey sea-snake, caught on the Saigon cable in a depth of thirty fathoms, and a black and white brindled snake, taken from the Batavian cable in twenty-five fathoms. Twisting round ropes seems to be a habit of this creature, for the writer remembers seeing one scale up a ship's side out in the River Amazon, by the "painter" hanging in the water.

A good example of a feather-star is also shown; these animals, being frequently found grasping the cable by their tentacles. A handsome specimen of the blanket sponge, picked up in the Bay of Biscay, is also exhibited; but the most interesting object of all is a short piece of cable so beautifully encrusted with shells, serpulæ, and corals, as to be quite invisible. It was picked up and cut out in this condition from one of the Singapore cables. The rapid growth of these corals is surprising, and some valuable information on this head might be gained if the electricians of repairing ships in these eastern waters would only make some simple observations. Curiously enough, so long as the outermost layer of oakum and tar keeps entire, very few shells collect upon the cable, but when the iron wires are laid bare, the incrustation speedily begins, perhaps because a better foothold is afforded.

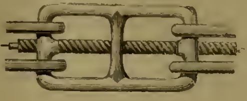


Fig. 1.

Fig. 2.

Fig. 3.

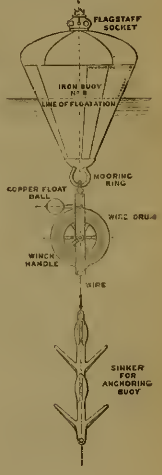


Fig. 4.

A deadly enemy to the cable, in the shape of a large boring worm, exists in these Indian seas; and several of them are shown by the Company. The worm is flesh-coloured and slender, of a length from $1\frac{1}{2}$ inches to $2\frac{1}{2}$ inches. The head is provided with two cutting tools, of a curving shape, and it speedily eats its way through the hemp of the sheathing, to the gutta-percha of the core, into which it bores a hole similar to that shown in Fig. 3.

---

[1] "On some South American Phenomena" (J. Munro).

A full account of this particular worm, with anatomical illustrations, is given in the *Journal* of the Royal Microscopical Society for October, 1881, by Dr. Charles Stewart, secretary of the Society. The bore-holes, after passing through the oakum of the inner sheathing, either pursue a tortuous course along the surface of the gutta-percha core, or go right into the copper wire, thereby causing a "dead earth" fault. Dr. Stewart classes the worm as one of the Eunicidæ, but proposes for it the generic name of *Lithognatha worslei*, because of its possessing a pair of calcareous mandibles or cutting jaws, and after Capt. Worsley, the Commander of the repairing ship which picked up the worm-eaten cable. The pair of calcareous jaws, in addition to three pairs of chitinous ones, is the most remarkable feature about the animal, and the white plates which form them make the creature look as if it were in the act of swallowing a tiny bivalve shell.

The best protection hitherto formed against it is to cover the core with a ribbon of sheet-brass, laid on without a lap. First the gutta-percha is covered with cloth, then the brass is overlaid. Canvas is then put over the brass, and the hemp and iron wires over all. A close layer of iron wires is not a sufficient protection, for the worm can sometimes wriggle in between the wires where they are not close enough; and, moreover, the rapid decay of iron wires in tropical seas is certain to leave the core a prey to these pests in a few years.

The Eastern Extension Telegraph Company also exhibit some interesting samples of stones picked up from the sea-bottom; for example, limestone blocks and shells bored by the bivalve, *Saxicava ragosa*, the worm Sabella, and the sponge *Hymeniacidon celata*; wood honeycombed by the teredo, a red stone pitted by the bivalve shell (pholas), and a ferruginous flaky stone brought up from the bottom between Penang and Singapore. Most interesting, however, of these inanimate waifs is a flat piece of black flinty rock hollowed into cup-like pits by the sucking feet of the sea-hedgehog. The pits are excavated as lairs for the animal and some of them are nearly three inches in diameter by one inch deep. To make the rocky bed softer to the feel, the hedgehog has lined it with a calcareous enamel, probably secreted by its body, much in the same way as the pearl oyster coats its shell.

In the earlier days of submarine telegraphy, Sir William Thomson declared the life of a cable to be practically inviolable; and Robert Stephenson, on the other hand, was of opinion that no cable would last out ten years. The latter view has proved the more correct, for the average life of a cable hitherto has been about eleven years. Thanks to the improved means of repairing them, however, the outbreak of faults does not mean the loss of a cable, for these flaws can be cut out in water, however deep, and the cable put to rights again. Indeed every cable company expects a recurrence of faults, and provides a fully-equipped repairing ship always on the spot. A fine model of such a ship is exhibited by the Post Office, after the designs of Mr. R. S. Culley. Messrs. Johnson and Phillips also exhibit a variety of buoys and grapnels for cable operations. The ordinary grapnel is liable to have its prongs broken off in dragging over a rocky bottom, as may be seen from one exhibited which had every prong bent back among the coral reefs of the Brazilian coast. Centipede grapnels are therefore fitted with removable prongs; and Mr. A. Jamieson has invented a grapnel with spring teeth which bend back when they meet a rock, so as to slip over it, but catch and hold the cable. A sample of this grapnel is shown in the Western Gallery, and a sample of Messrs. Johnson and Phillips' grapnel for cutting the cable and holding one end is shown in front of the Roman court, together with a very large buoy for buoying the cable in deep water. A very convenient and novel "mark" buoy for marking positions in cable work is exhibited by the same firm in the Western Gallery. The buoy is suspended by a line from the ship's quarter or stern, and when the line is cut, the buoy drops into the water. The copper float ball (see Fig. 4) is then raised, and lifts a detent which allows the drum of steel wire to revolve. The centipede anchor then sinks to the bottom, and moors the buoy. A winch handle is provided, so that the moorings can be recovered if need be, but the cost of the sinker, drum, and wire is so slight that it may readily be abandoned. While upon the subject of deep-sea operations, we may also mention the "nipper lead" of Mr. Lucas, by which specimens of the sea-bottom are caught in two spoons or tongs hinged to the bottom of the lead, and kept apart by a trigger arrangement, which is sprung by the lead striking the bottom.

Coming now to the working of submarine cables, there are several very neat mirror galvanometers exhibited by Messrs. Latimer Clark, Muirhead, and Co. The Eastern Telegraph Company exhibit the siphon recorder of Sir William Thomson, working through one of Dr. Muirhead's artificial cables on the duplex system, the counter instrument being placed at the stall of the School of Telegraphy. The bold electromagnets of this fine instrument have been excited hitherto by Sir W. Thomson's large tray-form of Daniell cell; but quite recently Mr. Clement Chevallier, electrician to the Eastern Telegraph Company at Aden, has substituted permanent magnets, with a great gain in economy. These magnets were specially made by Mr. Le Neve Foster, at Silvertown, and their magnetic power is much heightened by a small percentage of tungsten in the steel. An interesting experiment, showing the retardation of signals through a long submarine cable, is made by the School of Telegraphy. Ten mirror galvanometers, throwing ten light-spots in a vertical row on a white screen, are connected in turn at different points of a long cable, and the travel of the charge when the circuit is closed by a key is shown by the successive movements of the light-spots across the screen.

Mr. C. F. Varley, F.R.S., who by his application of condensers to the submarine circuit did so much to improve cable signalling, has a very interesting exhibit of his past inventions. These include his gravity battery patented in 1854 (No. 2555), and repatented in 1861 by Menotti, whose name it bears. In the same patent the sulphate of mercury battery, subsequently known as the Mariè-Davy, was also described. This patent, like most of Mr. Varley's, was very rich in devices, and contains his application of the condenser not only to telegraphy, but to electric lighting, a plan subsequently patented by Jablochkoff. Mr. Varley's exhibit also includes the first polarised relay used in this country, and the rotary electrical machine made and patented in 1860, and held by him to be the parent of the Holtz and other induction machines, such as the mousemill of the siphon recorder and the replenisher of the quadrant electrometer. But it is probable that Mr. Varley's claim must give way in favour of M. Belli, who invented a similar induction machine many years ago, which the writer saw in the Retrospective Museum of the recent Paris Electrical Exhibition.

THE EARLIEST USE OF THE INCANDESCENT ELECTRIC LIGHT

A CORRESPONDENT writes:—

The following extract from a memoir by Sir William Grove, published more than thirty-six years ago, will be of interest to future historians of the progress of lighting by electricity. The memoir is entitled "On the Application of Voltaic Ignition to Lighting Mines," by W. N. Grove, F.R.S., and is published in the *Philosophical Magazine*, May, 1845. It begins by stating that M. De la Rive had proposed the use of the voltaic arc for illuminating mines; it describes the apparatus employed by him, and the difficulties that prevented its practical application, and continues as follows:—

"I substituted the voltaic ignition of a platina wire for the disruptive discharge. Any one who has seen the common lecture-table experiment of igniting a platina wire by the voltaic current nearly to the point of fusion, will have no doubt of the brilliancy of the light emitted; although inferior to that of the voltaic arc, yet it is too intense for the naked eye to support, and amply sufficient for the miner to work by. My plan was then to ignite a coil of platinum wire as near to the point of fusion as was practicable, in a closed vessel of atmospheric air, or other gas, and the following was one of the apparatus which I used for this purpose, and by the light of which I have experimented and read for hours:—A coil of platinum wire is attached to two copper wires, the lower parts of which, or those most distant from the platinum, are well varnished; these are fixed erect in a glass of distilled water, and another cylindrical glass closed at the upper end is inverted over them, so that its open mouth rests on the bottom of the former glass; the projecting ends of the copper wires are connected with a voltaic battery (two or three pairs of the nitric acid combination), and the ignited wire now gives a steady light, which continues without any alteration or inconvenience as long as the battery continues constant, the length of time being of course dependent upon the quantity of the electrolyte in the battery cells. Instead of making the wires pass through water, they may be fixed to metallic cups well-luted to the necks of a glass globe.

The spirals of the helix should be as nearly approximated as possible, as each aids by its heat that of its neighbour, or rather diminishes the cooling effect of the gaseous atmosphere; the wire should not be too fine, as it would not then become fully ignited; nor too large, as it would not offer sufficient resistance, and would consume too rapidly the battery constituents; for the same reason, *i.e.* increased resistance, it should be as long as the battery is capable of igniting to a full incandescence."

The memoir concludes with the description of experiments on the illumination power of this contrivance under different conditions.

THE ENGLISH ECLIPSE EXPEDITION

THE following communication, under date lat. N. 37·8, long. E. 11·10, April 27, has appeared in the *Daily News*, from the special correspondent of that paper with the English Eclipse Expedition:—

Your correspondent so far has not had a very easy time of it, although it must be confessed his difficulties have been in no way connected with lack of material. Chronicling attempts to advance beyond the frontiers of the known must always be a pleasant task to the chronicler, who is thus enabled to be among the first to reap the rich intellectual rewards always gained, or nearly always gained, in such forays. But when the task brings him in full view of other interests, and especially when it compels him to observe phenomena for himself, a correspondent's task may become complicated beyond measure, and not only the *embarras de richesses*, but even a mental revision of his instructions, however precise they may have been, may give him trouble. Thus, in the present case, my clear duty is to keep pace with the thoughts and doings of the Eclipse party now on the *Kaisar-i-Hind*, between Gibraltar and Malta; but am I therefore to be blind to the fact that each P. and O. ship does not leave Gravesend with two tons of telescopes and eyes to use them, and that the infusion of a scientific party into the general run of passengers on this the most important of England's seaways, cannot but cause what our American cousins would call a "ripple" on the ordinary routine of ship-life.

Those who have made their way to the far East many times, and who are therefore quite familiar with this routine, will at once recognise the possibility that at first such *raræ aves* were looked at askance. Was there not at least some strange power of divining secrets in sextants, spectroscopes, and cameras brought now and then, and with a kind of furtive air, from hidden recesses? And this being so, what conduct was more natural on the part of the non-scientific members of the party, than that they should show a keen anxiety to assure everybody that they at least knew next to nothing of science—in short, that though they might deplore these strange and aberrant tendencies, they were powerless to interfere, even if the studies were less harmless than they believed them to be. This, at first, of course confirmed the general impression, but it did not take long for the ice to melt; the strange feeling soon wore off, and after a fierce gale which the *Kaisar-i-Hind* encountered in the Bay of Biscay had abated, the keenness of everybody on board to hear something of a world of marvels new to most of them, and the anxiety of every servant of the P. and O. Company, from captain to boatswain, to help, whenever help was needed, were the predominant features.

The delight of the Somali boys at being photographed was a sight to see, their broad grins being in strange contrast with the evident anxiety of the Arabs among the crew to escape the influence of such a possible evil eye. While this is going on in one part of the ship, the reflection of the summer sun shimmering from a thousand Mediterranean waves through which the noble ship ploughs her way on an even keel is utilised to show the wondrous work which has already been done by the spectroscope. Nor are the other worlds, still left to conquer, forgotten in the demonstration; among them, those secrets of the Sun which it is hoped may be unveiled during the coming precious seventy seconds. And this brings me to the proper subject matter of the present letter. What, then, are the astronomers going to do? or, to put it more modestly, what are they going to try to do? Before a categorical answer can be given to this question there is some preliminary matter to be got over; we have, in fact, to consider the changes in thought and methods introduced by ten years of work. A volume might be written on this, but a very brief *exposé* is really all that is required on the present occasion. The brilliant achievements of physical astronomers in the domain of solar physics during the last twenty years have dealt in the main with the chemical and physical construction of the atmosphere of our central luminary; that is, those parts of it which are furthest from the centre. In fact, it has been a question of meteorology, and not a question of geology, to use terrestrial equivalents. One of the first things made absolutely certain was that the outer atmosphere for tens and perhaps hundreds of thousands of miles above the surface of the round orb we generally see and call the Sun, is intensely hot—hot enough to have its clouds built up of vapour of iron, as in our own air we have clouds built up of the vapour of water. Next, as the work went on, two things happened. First, certain and sure evidence was obtained that the outer atmosphere extended much farther from the sun than had been previously supposed by those most competent to form a just opinion; and, further, while the extent of the atmosphere was thus engaging attention, the chemical inquiry had been carried so far that we thought we were justified in saying, not only that the sun's atmosphere contained just such substances as ours would do if our little earth were suddenly turned into a mass of vapour, but that certain substances occupied such and such positions in the atmosphere, while others were to be sought for elsewhere.

Thus outside all, it was imagined, there was a substance about which we know nothing here, because we cannot find anything which produces the same spectrum. Inside this, at mid-height in the sun's atmosphere, we got indications about which there could be no mistake—we were in presence of hydrogen: incandescent hydrogen, be it observed, which plays as important, or indeed a still more important part in the solar air than nitrogen does in our own. Next it was imagined that close to the sun itself there was a vaporous sea containing all the other substances which had been detected by the spectroscope—magnesium, calcium, iron, barium, cobalt, nickel, and some twenty other bodies termed "elements" by the chemist, because he cannot reduce them to a condition of greater simplicity. As the sum total of these inquiries, then, we had some such idea of the sun's atmosphere as this: Physically it was incandescent, of enormous extent, very irregular in outline, its extent and outline varying almost every time it could be observed. Chemically it was built up of substances known to terrestrial chemistry; it was very simple at top, and very complicated at bottom. This mental image was the joint product of both laboratory and eclipse work. The solar spectrum—that is, the beautiful rainbow ribbon which is produced when light from the sun is made to pass through a prism—enabled us even in our laboratories, without a telescope, to study the chemistry of the sun's atmosphere as a whole, but such work as this localised nothing. Further, the outer atmosphere is so dim as compared with the intensely brilliant interior nucleus, that it, like the stars in the daytime, is put out, and remains invisible so long as the sun itself is in a position to illuminate our upper air. In this we have the use of total eclipses, for at such times the moon prevents the sunlight from falling on our atmosphere, and the sun's atmosphere shines out in all its weird splendour, as the stars show themselves when the light of day is withdrawn. It is fair to add, that there is a method which enables us to study the chemistry and even the meteorology of the very brightest portion of the sun's atmosphere, called the chromosphere, without waiting for an eclipse, but still, every allowance being made, it should be now clear that to study the physical attributes of the atmosphere as a whole, we are strictly limited to total eclipses. So much, then, for our brief *exposé*. There is still some more ground to be gone over before the question with which we set out is answered. What was the sum total of the work done during the last eclipse—that observed in the United States in 1878, with a wealth of instrumental appliances such as had never been used before? How did it deal with our received notions? Did it endorse them or demolish them?

It certainly endorsed them in the main, while it enabled us to accumulate a vast amount of new knowledge on many important points, and showed us how every effort should be made to secure these precious records. Among other things, it intensified the difference between eclipse and eclipse, for the spectroscopic record of the outer corona—as the exterior atmosphere is sometimes called—differed very considerably from the one secured in 1871, and it was a noteworthy fact that the eclipse of 1871 happened when there were most spots on the sun, while that of 1878 took place when there were fewest. I said "in the main." But during the eclipse one observation was made, which in the light of former laboratory work suggested that after all there was a rift in the lute, and that our view of the solar economy might be much more wrong than we had any idea of. Since 1878 that same laboratory work has been continued, and a long series of observations of the spectra of sun-spots has been made, and the tendency of all this extra eclipse-work has all been in one direction. We are now face to face with the idea that, in the hottest part of the sun, the temperature is so high that our so-called elementary bodies are broken up into simpler ones, and that the reason that the sun seems to contain so many of our terrestrial elements is simply that both in the sun and in a powerful electric spark these bodies are really broken up into their finer constituents, the spectral lines of these finer constituents being observed in both cases. Now it is obviously the duty of men of science, if there be any tests of this new view, any crucial observations possible during an eclipse, to apply these tests, to make these observations, as soon as possible—not, of course, to the neglect of the old methods of attack, but, if possible, in addition to them; and as the problem is one of such general interest, and one which is sure to be keenly debated, as many records independent of personal error or personal bias should be obtained as possible. These permanent records, to which reference has been made, are of course photographs, and here we are brought face to face with another fact; we have not only a new view to test, but we have new photographic processes to apply to test it, as well as to obtain a series of records comparable with those secured during prior eclipses. We have in this case an instance of the way in which an observation, apparently trivial, is at last seized hold of and made to furnish a stepping-stone for a further advance in scientific inquiry. It is now many years since Faraday, experimenting on gold leaf, which is green when a bright light is observed through it, found that he could change its colour, and he fancied that this might be taken to indicate that the gold in the leaf did not consist of particles all of the same size, but that they existed of almost an infinite series of finenesses. This was in the pre-spectroscopic days. When the spectroscope could be brought to bear, it became apparent that two orders of fineness only were required to produce all the colours observed by Faraday, and Mr. Lockyer soon produced other evidence which went to show that we were here in presence of a general law. From this time we heard the words "blue molecules" and "red molecules"—terms invented to indicate that in the same chemical substances there were some molecules with such physical attributes that they were turned to and could therefore absorb blue light, while others were made active by red light falling upon them.

Capt. Abney, in a series of painstaking researches, has shown that precisely those salts of silver employed by photographers obey this general law, and hence we can now use blue light and red light indiscriminately, and so, for the first time we can photograph the red end of the spectrum of the sun's external atmosphere. Nor is this all; other advances in the photographic art enable us now to replace minutes by seconds in the time of exposure; indeed, in these days of "instantaneous" processes, the difficulty often lies in exposing the plate for a time short enough to the influence of the light. It is as well to insist upon this point, as in the eclipse of next month the totality or period during which the moon entirely covers the sun is very short; but short as it is, it is more than made up for by the increased rapidity of the processes to be employed. Now, the most important phenomena to be recorded, whether by eye or photography, are, first, the spectrum of the lowest stratum of the sun's atmosphere revealed to us at the moment of disappearance and reappearance of the sun by a sudden flashing out of bright lines; next, the spectrum of the outer atmosphere, best observable at mid-eclipse; and then the extent and structure of the atmosphere itself. Now it is imagined, that if the new view to which reference has been made is correct, the spectrum of the lower stratum will differ from what it is supposed to be, and we say supposed to be, because up to the present time the observations have been of such a general nature that it has been impossible to be quite certain about details. The intention this time is to observe a small portion of the spectrum with great minuteness, so far as the eye observations go, while an attempt will be made to actually photograph the flash of bright lines, and obtain a reference spectrum afterwards by obtaining a photograph of the solar spectrum on the same plate after the eclipse is over.

Among the most interesting observations made during the total eclipse of 1878—duly chronicled in the *Daily News* at the time—was one by which Prof. Newcomb demonstrated a tremendous extension of the corona in the direction of the plane of the sun's equator, or very near it. It will be important to see, whether on the present occasion the extension will be so great, especially since Dr. Siemens has thrown down the gauntlet to astronomers by his bold speculations touching the circulation of the solar gases. Such, then, are some of the things which the Eclipse Expedition is going to do, or going to try to do. If all goes well, I shall be able in my next letter to tell your readers something of a definite nature as to the actual camping-ground and the local arrangements in Egypt.

The following telegram from its special correspondent is given in Tuesday's *Daily News* :—

Sohag, Monday

The preparations are complete for the eclipse on Wednesday, thanks to the assistance rendered by the representatives of the Egyptian Government to the English, French, and Italian observers alike. The weather is apparently settled. There is little probability of dust-storms. The greatest heat experienced is 108 in the shade. The temperature is now cooler. The English party will probably return by Carthage, leaving Suez on the 31st.

ALGÆ[1]

IT is little more than a year since the Latin edition of Dr. Agardh's work on the "Morphology of the Florideæ" was noticed in the pages of NATURE. The author now sends us another contribution to the systematical study of algæ. The present is, however, not a distinct work, but a continuation of a series of Essays or Monographs, the first instalment of which appeared in vol. ix. of the *Transactions* of the University of Lund, in the year 1872. The subjects of the first instalment were the genera Caulerpa and Zonaria, and the classification and description of the Australian species of certain tribes of Sargassum.

The present work consists of essays on the CHORDARIEÆ, and on some of the DICTYOTEÆ. Although it bears a Swedish title, it is written in Latin. It commences with a monograph of the family Chordarieæ, which is entirely reconstructed, and is enlarged by the introduction of several new genera. Under the present arrangement it comprises seventeen genera.

From the increased activity recently shown by British algologists whose exertions have been rewarded by the discovery of many species of Algæ new to these shores, it would seem desirable to mention more particularly a few of the changes which have been made in the present work by Dr. Agardh in the classification of some of the plants of the olive series of Algæ.

Beginning with Elachistea, as the author, restoring the old spelling, prefers to call it, we find that this genus is removed to the CHORDARIEÆ. This is in accordance with the views of Dr. W. H. Harvey, expressed in the "Phyc. Brit. Tit." *E. fucicola.* This genus is especially interesting from the fact that out of the nine species, seven are British. *E. velutina* (of the "Phyc. Brit." pl. xxviii. B), removed by Thuret to Streblonema, is placed by Dr. Agardh in his new genus Herponema (see p. 55).

The next genus, Myriocladia, includes *M. Loveni*, an extremely rare species, which has been obtained growing on oysters in deep water in the Baltic, and which Dr. Agardh ("Sp. Alg.", p. 53) states was found by the late Mr. Borrer on the Sussex coast; it has not, however, been met with by succeeding observers; neither has Dr. Agardh seen the plant in other collections. The name of this rare plant does not occur in the published lists of Algæ found by Mr. Borrer. A representation, much enlarged, of some of the details of the plant, will be found on Pl. 1, Fig. 3.

The genus Mesogloia is now restricted to two species, *M. Mediterranea* and *M. vermicularis. M. virescens* is removed to Eudesme, of which another species inhabits Tasmania and South Australia. *Chordaria divaricata* and *Mesogloia Griffithsiana* are now respectively *Castagnea divaricata* and *C. Griffithsiana.* The observations on the structure and fruit of the epiphytic plants, which constitute the genera Myrionema and Herponema, will be interesting to British algologists.

Among the new Algæ which have been recently added to the British Marine Flora, is the handsome plant found by Mr. G. W. Traill, in the Firth of Forth, and issued to British collectors under the name of *Dictyosiphon Hippuroides.* The plant was first described and figured by Lyngbye in the "Hydrophytologiæ Danicæ," under the name of *Scytosiphon Hippuroides;* then, in Agardh's "Sp. Gen. et ord. Alg.", vol. i. p. 66, as *Chordaria flagelliformis*, var. *B. Hippuroides.* Areschoug subsequently distributed dried specimens of the plant, and published (*Bot. Notiser*, 1873, No. 6., and *Obs. Phycol.*, iii. 1875) descriptions of it under the name of *Dictyosiphon Hippuroides.* In the present work Dr. Agardh maintains the opinion he had expressed in "Sp. Alg." more than thirty-three years ago, that the *Scyt. Hippuroides* of Lyngbye is a form of *Chord. flagelliformis*, and not a Dictyosiphon. He supports his views by a minute description of the structure of the frond, and gives at length (pp. 67-70) his reasons for differing in opinion from his old friend Dr. Areschong. As a proof of the care with which Dr. Agardh conducted his examination of the plant, it may be mentioned that he describes and names six forms of it, including among them, *Scyt. Hippuroides*, Ll., and *Scyt. tomentosus* or Fl. Dan. and Lyngb. British algologists will find this part of Dr. Agardh's work particularly interesting.

Among the Algæ which have been recently added to the British Marine flora are *Phlæospora tortilis* (Rupr) Aresc., and *Dict.* (*Coilonema*) *mesogloia*, Aresc.; it may be mentioned incidentally that Dr. Agardh considers both Phlæospora and Coilonema as distinct genera.

The DICTYOTEÆ.—The author commences with preliminary remarks on the limits of the family, and the structure and fructification of the different genera (pp. 77-83). Then follows an elaborate essay on the genus Dictyota (pp. 83-92); and after that a description of the species, and the tribes under which they are arranged. Of the twenty-six species, one only, *D. dichotoma*, is a native of our shores. Six other species are referred to Dilophus, J. Ag., and two to Glossophora, J. Ag.

The genus Spatoglossum, Kg., includes *Taonia Solierii*, *T. Schrœderi*, and two others. Then follow a few observations on *Taonia atomaria.* Padina is treated at greater length. To this succeed elaborate observations on the structure and fructification of Zonaria (pp. 120-131), and some remarks on certain species. This part of the work, it must be observed, is supplementary to the article on Zonaria in the first part of the "Bidrag," p. 45. before referred to, in which the several species are described.

It may here be remarked that the *Zonaria collaris* of the "Phyc. Brit." has no claim to be considered as a native of the British Isles. It is found in the Mediterranean and Adriatic, and occasionally in Granville Bay, on the French coast. It is not a Zonaria, but a Cutleria.

The work concludes with some observations on the species of Halyseris.

In the selection of the preceding subjects for remark, the writer has been guided by the interest which, it was thought, would be taken in them by British algologists; it must, however, be observed that the work has also many points of interest as regards Australia, Tasmania, and New Zealand. Among the species belonging to the

---

[1] Til Algernes Systematik. Nya bidrag af J. G. Agardh (Andra Afdelningen) Lunds Univ. Årsskrift. Tom. xvii. (4to., pp. 134).

CHORDARIEÆ, sixteen are natives of these colonies; while in Dictyota, Dilophus, and Glossophora, which, together contain thirty-four species, no fewer than fifteen belong to the same localities.

It is almost superfluous to say that the work in every part gives evidence of the careful and patient observation which characterise all the writings of Dr. Agardh, and render them so valuable an aid to the study of algology. It is to be hoped that before long we may have the pleasure of welcoming another instalment of his contributions to the study and classification of the Melanosperms.

M. P. M.

NOTES

THIS week we give the first of a short series of articles on the life and work of the late Mr. Darwin. The series is under the general care of Dr. G. J. Romanes, F.R.S., who also will take special charge of the Zoology and Psychology. The Geology will be by Prof. Geikie, F.R.S., Director of the Geological Survey, and the Botany by Mr. W. T. Thiselton Dyer, F.R.S.

THE first meeting of the Executive Committee of the Darwin Memorial was held in the rooms of the Royal Society on Tuesday, May 16, at which it was resolved that subscriptions be invited in order to promote such a memorial of the late Mr. Darwin as shall seem most fitting, having regard to the amount that may be collected. Subscriptions will be received by Mr. J. Evans, Treasurer, Royal Society, Burlington House, W.

AT a meeting of Convocation of the University of London held May 9, the following resolution was unanimously passed:—"The Graduates of the University of London, in Convocation assembled, desire to record their sense of the irreparable loss which science and philosophy have sustained in the death of Mr. Darwin, whom they recognise as an acute and patient investigator, an earnest seeker after truth, and an original thinker, whose discoveries have exercised a profound influence upon scientific research and upon the progress of scientific thought throughout the world."

A NOVEL feature at the meeting of Convocation of London University, last week, was the appearance for the first time of female graduates in academical costume. Sir George Jessel, who presided, gave some statistics to show the rapid progress in the numbers availing themselves of the University's examinations, while Sir John Lubbock pointed out the progress that had been made in scientific education during the past year, referring especially to the City Technical Institute. "What is wanted," he said, "is not so much money or men, as method and organisation, and to utilise the resources we already possess." He referred to the wasted resources of Gresham College, which, he said, ought to be "placed on a footing more in accordance than it has been with the wise designs of its noble founder." It was agreed to request the Senate to take definite steps with regard to this fossilised institution.

A WELL-DESERVED baronetcy has been conferred upon the eminent scientific agriculturist, Dr. John Bennet Lawes, F.R.S. The vast services rendered to agriculture by Sir John B. Lawes, in connection with Dr. Gilbert, are well-known. The new baronet, we learn from the *Times*, was born in 1814, and succeeded to his estate at Rothamstad, in Hertfordshire, in 1822. Mr. Lawes was educated at Eton and at Brasenose College, Oxford, where he remained from 1832 to 1835. During his academic career he displayed at once a strong partiality for the laboratory, and on leaving the University, spent some time in London, for the purpose of studying in a practical manner the science of chemistry. Possessed of independent means, a handsome property, and a beautiful old manor-house and demesne, Mr. Lawes at once interested himself in agriculture. In October, 1834, he first commenced regular experiments in agricultural chemistry on taking possession of his property and home at Rothamstead, and from that date up to the present time Mr. Lawes has unceasingly been applying his scientific knowledge to the solution of questions affecting practical agriculture. Sir John Lawes, we believe, has not only entirely maintained his experimental farm of 500 acres, but has further set apart a sum of 100,000*l.* and certain lands for the convenience of the undergraduates after his death. This is indeed a gift to the nation, a gift, too, which no money value adequately represents.

MR. F. V. DICKINS, M.B., B.Sc., has been appointed Assistant Registrar to the University of London, in succession to Prof. Moseley.

THE second meeting of the Bohemian Naturalists and Physicians will take place at Prague during May 24-30, to celebrate the foundation of a Slav University in that city.

M. COCHERY, the Minister of Postal Telegraphy in France, has printed a circular extending the use of telephones to provincial cities. The charge for telphonic communications in the cities where the government will establish central halls, is 10*l.*, and in the cities where the number of subscribers will exceed 300, the subscription will be reduced to 8*l.* a year. The subscribers will have the right of supplying their own telephones from among those approved by the Government. Special rooms will be fitted up in Paris, as well as in the provinces for telephonic conversations. The charge will be 5*d.* from each interlocutor for each five minutes. The time allowed will not exceed ten minutes if there are other would-be interlocutors waiting. The telegrams received for the subscribers to the telegraphic offices will be telephoned to them if desired. The subscribers will enjoy the privilege of telephoning their letters to the Post Office for immediate despatch, on paying a charge of 5*d.* for each 100 words; this privilege is limited to 200 words, the postage must be paid besides. Telegrams will be received in the same manner and on the same scale.

DURING the last two or three years a bark containing quinine and quinidine has been imported into this country from Columbia in such enormous quantities as to equal or even sometimes exceed the whole of the importations of cinchona bark from all other countries. The botanical source of this bark, which is known in commerce under the name of Cuprea Cinchona, on account of its peculiar coppery tint, has hitherto been a mystery. M. Triana, the well-known quinologist, has recently succeeded in tracing it out, and has stated, in the *Pharmaceutical Journal* for April 22, that it is derived in great measure from two species of the nearly allied genus *Remijia*, none of the members of which were previously known to contain quinine. Several species of *Remijia* have leaves resembling those of the true Cinchonas, and of these M. Triana has determined that *R. Purdieana*, Wedd., and *R. pedunculata*, Karsten, certainly yield Cuprea bark, the former being the species which contains the alkaloid Cinchonamine, recently discovered by M. Arnaud. It appears probable that other species also yield the Cuprea Cinchona of commerce, but definite information on this point is still wanting. The value of this bark has led, according to M. Triana, to great devastation of the forests in which the trees grow, and has produced a financial stagnation, business being neglected in order to follow the more profitable occupation of collecting the bark. Fortunately seeds of the tree have been received and are now in cultivation at Malvern House, Sydenham. The tree is likely to prove valuable for cultivation in countries where malarial fever abounds, since it grows at an elevation of 200-1000 metres above the sea, at which even red Cinchona bark will not flourish.

A SATISFACTORY *Report* for 1881 has been issued by Mr. Paton, curator of the Kelvingrove Museum, Glasgow. The natural history collections especially have greatly increased during the past year, and if displayed properly, would themselves fill the Museum. It seems strange that so wealthy a city as Glasgow should be content to have their growing and valuable museum so inadequately housed.

DR. P. A. BERGSMA has resigned his appointment as Director of the Batavia Observatory, and is returning to Europe. We have often had occasion to refer to the good work done by Dr. Bergsma at this Observatory, especially on Meteorology.

MR. HENRY DYER, the efficient principal of the Imperial College of Engineering, Tokio, Japan, is about to return to this country.

THE death is announced of Col. J. T. Smith, R.E., F.R.S., for many years Master of the Mint at Madras, and the author of some valuable optical discoveries.

WE regret to learn of the death, at the early age of thirty-two, of a promising young science teacher and lecturer, Mr. Thomas Dunman, lecturer on Physiology at the Birkbeck Institution, and Physical Science Lecturer at the Working Men's College. His brief career furnishes a remarkable instance of what may be done by energy, perseverance, and a strong faith in one's own powers. Mr. Dunman has done excellent work in science teaching at both of the institutions mentioned. In 1879 he published a glossary of "Biological, Anatomical, and Physiological Terms," and finding his Lectures on Popular Scientific Subjects were so much appreciated, he commenced last year to issue them in pamphlet form.

MESSRS. BAILLIÈRE, TINDALL, AND COX have the following announcements:—A revised and enlarged edition of Harris and Power's "Manual for the Physiological Laboratory" will appear on June 1; a second edition of the Portrait-picture of the International Medical and Scientific Congress of 1881 is in course of preparation, with a few additional portraits; a second part of the President of the Royal College of Veterinary Surgeons' (Mr. Fleming) work on "Animal Plagues," from the beginning of the present century, will be published during the next few days.

PROF. ROSCOE, with other members of the Royal Commission on Technical Instruction, visited Vienna during the past week. Mr. Samuelson, M.P., the president of the Commission, and Mr. W. Woodall, M.P., left on Friday to join their colleagues at Dresden. After inspecting the schools and manufactories in Saxony, it is the intention of the Commissioners to proceed to Berlin.

WE have received copies of a circular letter and inclosures which have been issued to the scientific societies of the United Kingdom (with the exception of the Chartered London Societies, and the medical and some few other societies of a similar character) within the last few days. These papers are issued in pursuance of the resolutions adopted at the second Conference of Delegates of Scientific Societies held at York. Any society desirous of receiving these, or intending to send a Delegate or Delegates to the Southampton Meeting of the British Association, should apply to Mr. W. G. Fordham, Odsey Grange, Royston. Mr. Fordham would be obliged to secretaries of scientific societies, or any of our readers, who would assist him in compiling a complete list of the scientific societies of the United Kingdom, by sending him information, particularly with reference to the smaller provincial and local natural history societies, and similar bodies.

WE have received the Annual Reports of three local scientific societies—East Kent, West Kent, and Wellington College. They all speak favourably of the work of the past year and of the progress of the societies. The Report of the West Kent Society contains a sensible address on Evolution, by the president; and that of the Wellington Society shows that considerable improvement has taken place since the last report.

ON Saturday afternoon last the members of the Essex Field Club met in the private lecture-room in the Natural History Museum, South Kensington, at the invitation of Dr. Henry Woodward, F.R.S., who delivered a very interesting and instructive lecture on the "Ancient Fauna of Essex." The lecture was amply illustrated with specimens and diagrams, many of the latter being specially prepared for the occasion, and at its close Prof. Morris gave a brief *résumé* of the principal facts of the geology of the Thames and Roding Valleys. Dr. Woodward afterwards conducted the party through the palæontological galleries, and practically demonstrated many of the more remarkable forms referred to in his lecture.

THE funds voted by the French Government for the next Transit of Venus Expedition not being deemed sufficient, the great commission presided over by M. Dumas in consequence of the deficiency, is making an application to the Minister of Public Instruction for an extension of credit.

M. ELOY, a young aëronaut who executed on Sunday, May 7, an interesting ascent, reported at full length to the Academy of Sciences on the following day, is to make a series of scientific ascents from La Villette Gasworks, and has submitted to M. Dumas a detailed programme of his proposed observations. We may state that their bearing is mostly on the nature of clouds, their dimensions, their formation, their propulsion by the wind, and their situation in the several strata of air by which they are propelled. The questions proposed by M. W. de Fonvielle to Dr. Hermann Kopp will be solved as far practicable.

A LARGE Lacustrine canoe, in excellent condition, has been found near Bex, 4000 feet above the sea-level, and nearly 3000 feet above the Valley of the Rhone. No Lacustrine relics have ever before been met with in Switzerland, at such an elevation.

AN International Hygienic Conference is to be held in Geneva in September next.

WE regret to learn that the Hygienic Exhibition which was in preparation in Berlin has been almost destroyed by fire; but the Committee have resolved to carry out the enterprise next spring.

HIS EXCELLENCY the Marquis of Lorne, Governor-General of Canada, has instituted a Society for the "Advancement of Literature and Science in the Dominion of Canada," the first meeting of which is fixed to take place in the city of Ottawa on May 25, 26, 27. The President is Principal J. W. Dawson, C.M.G., F.R.S.

THERE is an interesting paper in the last number of the *Revue Scientifique*, by M. Ch. Cornevin, on the Domestication of the Horse.

IN connection with the election of M. de Freycinet to the Paris Academy of Sciences, it may be noted that not less than twenty-four members of the Sénate belong to the several classes of the Institute of France, seven to the Academie Française, five to the Academy of Sciences, Morals, and Politics, five to the Academy of Inscriptions and Belles Lettres; of these twenty-four, not less than twenty are life-senators, whose number is only seventy-five, and seven have been ministers. In the French Lower House the number of Academicians is very small, only three—two of the Academy of Sciences, one of these having been minister, and one of the Academie Française.

PROF. FOREL distinguishes three regions in a glacier:—1. The *nevé* (*infancy* of the glacier). Excess of snow; the summer heat not sufficient to melt the snow of the year. All the water produced is absorbed and assimilated by the ice-layers; deep temperature below zero. 2. The *glacier adolescent.* Summer heat fuses all the snow of winter, and attacks by ablation a part of the ice. All the water of imbibition is absorbed and assimilated by the ice; deep temperature below zero, even at the end of summer. 3. The *glacier senile.* Summer heat is in excess. The water of imbibition exceeds the quantity necessary to reheating of the ice, which rises to 0°, and the excess of water flows away in the glacial torrent. Temperature of the glacier at 0° during summer.

ON May 8 three shocks of earthquake were felt at Laibach (Carniola), the first occurring at 9h. 38m. p.m., the last, at midnight, was the most severe, and, lasting two seconds; it was accompanied by a loud subterranean noise.

ACCORDING to statistics recently worked out, the number of railway travellers killed in France is one in each 1,600,000,000 km. run, which is a distance equal to 40,000 times the length of a voyage round the world. This excursion would last during 3044 years travelling day and night at the rate of 60 kilometres per hour. So that, supposing an average life-time of sixty years for a healthy man, before he could be killed by a railway accident according to the law of probabilities, he would have died fifty times a natural death.

IN the Report of the Paris Academy of Sciences for April 24 (NATURE, vol. xxvi. p. 24) the statement with regard to Prof. Roscoe's paper "On the Equivalent of Carbon determined by Combustion of the Diamond" should read "Representing O by 15·96, C becomes 11·97." In the *Comptes Rendus* it is 11·07.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus* ♀) from India, presented by Mr. H. B. Hamer; a Common Paradoxure (*Paradoxurus typus*) from Java, presented by Mr. F. E. Spellerberg; a Black-faced Kangaroo (*Macropus melanops* ♀) from South Australia, presented by Mr. C. T. H. Bower; two Silver-backed Foxes (*Canis chama*) from South Africa, presented by Major-General E. A. Bacon; two Long-eared Owls (*Asio otus*), British, presented by Mrs. E. Brewer; two Alligator Terrapins (*Chelydra serpentina*), a Box Tortoise (*Terrapene*, sp. inc.), a Floridan Terrapin (*Clemmys floridana*) from North America, presented by Mr. G. E. Manigault; two Beautiful Finches (*Estrelda bella*) from Australia, presented by Mr. J. Abrahams; an Allen's Galago (*Galago alleni*) from Fernando Po, a Levaillant's Cynictis (*Cynictis penicillata*) from South Africa, a Common Otter (*Lutra vulgaris*), British, a Swinhoe's Pheasant (*Euplocamus swinhoii* ♀) from Formosa, five White-winged Choughs (*Corcorax leucopterus*), a Spotted Bower Bird (*Chlamydora maculata* ♂) from Australia, four Common Sheldrakes (*Tadorna vulpanser* ♂ ♂ ♀ ♀), European, two Talpacoti Ground Doves (*Chamæpelia talpacoti*) from South America, purchased; a Bennett's Wallaby (*Halmaturus bennetti* ♂), an American Bison (*Bison americanus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE COMET.—On May 12 the comet was within naked-eye vision, and will nightly increase in brightness. Writing from Cuckfield on May 13 Mr. G. Knott says: "The sky was very clear here last night, and I found that I could just see the comet with the naked eye, on knowing just where to look for it. I fancy that its visibility must have been in part due to the fact that its tail is pretty bright for about $\frac{3}{4}$°. When viewed with an opera-glass its light seemed hardly equal to that of neighbouring stars rated 6·7 (*i.e.* 6$\frac{1}{3}$) by Heis, and 6·5 by Argelander in D.M. In the telescope the light of the head seemed about equal to that of a 7 mag. star." This estimate by so careful and experienced an observer of star-magnitudes will furnish a reliable criterion as to the future increase in the brightness of the comet, assuming that it follows the ordinary theoretical rule.

The following orbit has been calculated by Mr. Hind from the observations at Harvard and Albany, U.S., on March 19, one at Paris on April 11, and a position obtained at the Royal Observatory, Greenwich, on May 4:—

Perihelion passage, 1882, June 10·51851 G.M.T.

	°	′	″	
Longitude of perihelion	53	54	23·2	Mean Equinox, 1882·0.
,, ascending node...	204	53	31·3	
Inclination...	73	46	23·2	
Log. perihelion distance... ...	8·783187			

Motion—direct.

By a meridian-observation at Greenwich on May 12 (eight days after the last observation employed for the orbit), which Mr. Christie has caused to be reduced with every precision, the corrections to the computed place were: $\Delta\alpha \,.\, \cos\delta = -9''\cdot0$; $\Delta\delta = +28''\cdot5$. Differential observations at the Collegio Romano, in Rome, on May 10, kindly communicated by Prof. E. Millosevich, give $\Delta\alpha \,.\, \cos\delta = -20''\cdot6$, and $\Delta\delta = +26''\cdot0$, parallax and aberration being taken into account.

The ephemeris subjoined is calculated from these elements for Greenwich midnight:—

	R.A.			Decl.		Log. dist. from Earth.	Intensity of light.
	h.	m.	s.	°	′		
May 20	2	53	31	+67	15·1	9·9494	1·67
21	3	5	49	65	51·0	9·9494	
22	3	16	51	64	22·5	9·9496	1·92
23	3	26	46	62	50·1	9·9502	
24	3	35	42	61	14·2	9·9511	2·24
25	3	43	45	59	35·2	9·9523	
26	3	51	2	57	53·1	9·9538	2·64
27	3	57	39	56	8·1	9·9557	
28	4	3	42	+54	20·6	9·9580	3·18

Considering that the comet is still at a great angular distance from the perihelion and the heliocentric motion slow, the following places for the beginning of June can be regarded as approximate only:—

At Greenwich midnight

	R.A.		Decl.		Log. distance.	Intensity of light.
	h.	m.	°	′		
June 2	4	27·1	+44	35	9·9747	6·0
3	4	30·8	42	27	9·9794	7·1
4	4	34·5	40	12	9·9845	8·8
5	4	37·8	37	51	9·9902	11·2
6	4	41·2	35	20	9·9965	15·2
7	4	44·8	+32	36	0·0036	22·6

The intensity of light on May 12, when Mr. Knott made his estimate of the comet's brightness, is here taken as the unit.

At noon on June 10, the intensity of light referred to this unit is 147, and at noon on June 11 it is 154. The probability of seeing the comet near the sun on these days is not now so great perhaps as it appeared to be from the earlier orbits.

At the meeting of the Royal Astronomical Society on the 12th inst., the Astronomer Royal referred to the absence of bright lines in the spectrum of the comet, according to repeated observation at Greenwich. It will be interesting to watch the comet's development as it approaches the sun.

BINOCULAR PERSPECTIVE

THAT a near object, of small size, presents an aspect slightly different to each one of a pair of eyes directed upon it seems to have been known since the time of Euclid; but not until the present century has binocular vision been made a subject of special study.

In 1838 Wheatstone presented a communication on the Physiology of Vision (*Phil. Transactions*, 1838, Part 2, reprinted in *Phil. Magazine*, s. 4, vol. iii. April, 1852) to the Royal Society, in which he described his invention of the reflecting stereoscope, by which rays from two slightly dissimilar pictures were conveyed into the right and left eyes respectively, producing the visual illusion of binocular relief. The essential feature of this instrument he describes by saying (*Phil. Mag.* April, 1852, p. 245): "The two pictures, or rather their reflected images, are placed in it at the true concourse of the optic axes."

In 1844 Brewster published an essay (Edinburgh *Transactions*, vol. xv. Part 3, p. 360) "On the Knowledge of Distance given by Binocular Vision," in which he elaborated the idea that the apparent position of the combined image produced by rays, from a pair of conjugate pictures, upon corresponding retinal points of the two eyes, is determined by the intersection of visual lines passing through conjugate points. He deduced a formula and constructed a table of apparent distances, thus determined, for various values of the angle of convergence between the visual lines.

In 1849 Brewster described his invention of the lenticular stereoscope (*Phil. Mag.* 1852, p. 16) and of the binocular camera, by which slightly dissimilar pictures of the same object may be simultaneously obtained for examination in the stereoscope. Various modifications of the instruments already in use were explained, and in all of them the apparent position of the combined image was referred to the point of convergence of the visual lines, these being determined by the direction of rays on entering the eyes after reflection or refraction in the stereoscope.

In 1852 Wheatstone published a second paper (*Phil. Mag.* 1852, p. 504) on the Physiology of Vision, in which he discussed the effects of varying the angle of convergence between the visual lines, and also the distance of the pictures from the mirrors of the reflecting stereoscope. He makes no reference to divergence of visual lines, but, like Brewster, he subjoins "a table of the inclinations of the optic axes, which correspond to the different distances," which is also applicable to the binocular camera.

In direct binocular vision of a single point in front the interocular line is the base of an isosceles triangle, whose two sides are the visual lines. Helmholtz ("Optique Physiologique," p. 93) has shown that the latter are not coincident with the optic axes, but practically they may be regarded as axial in relation to the crystalline lens. For distinction it will be convenient to call them visual axes, their intersection the optic vertex, and the angle inclosed the optic angle, as has been customary.

Let i = interocular distance,
,, α = optic angle,
,, D = distance of optic vertex from each eye,
Then
$D = \frac{1}{2} i \operatorname{cosec} \frac{1}{2} \alpha$.
If $\alpha = 0$, $D = \infty$, and visual axes are parallel.
If $\alpha < 0$, $D < 0$, and visual axes are divergent.

Wheatstone notices the exaggeration of perspective produced when a pair of conjugate pictures, taken with a large angle between the camera axes, are viewed in the stereoscope with the visual axes nearly or quite parallel. He mentions, as a remarkable peculiarity (*Phil. Mag.* 1852, p. 514), that "although the optic axes are parallel, or nearly so, the image does not appear to be referred to the distance we should from this circumstance suppose it to be, but it is perceived to be much nearer. It seems as if the dissimilarity of the projections, corresponding as they do to a nearer distance than that which would be suggested by the former circumstance alone, alters in some degree the perception of distance."

The last explanation is obviously inapplicable if two perfectly similar pictures can be binocularly seen as one, with parallelism or divergence of visual axis. This condition is easily imposed by placing before one eye a thin prism with its edge outward. A single object in front is seen double until the visual axis diverges enough to make the two images coincide in retinal position. To test the strength of the external rectus muscles of the eye-balls, this method has now been in use for many years by oculists. The same effect may be attained by drawing a pair of conjugate pictures apart until binocular fusion of their images ceases to be possible. Divergence of visual axes, to the extent of 8°, has been thus obtained by Helmholtz ("Opt. Phys.," p. 616), and of 7½° by the present writer. Since this point of meeting is, in these cases, in the rear of the observer, the theory of binocular prospective held by Wheatstone and Brewster is incorrect. It is nevertheless given without qualification, either directly or implicitly, in most, if not all, of our text-books of physics.

No analysis of the phenomena of binocular vision by axial divergence has thus far been published,

Helmholtz mentions the exaggeration of apparent distance thus produced, and adds ("Opt. Phys. p. 828") that "in our visual conceptions infinity is not presented as an impassable limit." He accounts for this by stating that in abnormal vision "all we can do is to compare the sensation produced with that which it resembles most in normal vision."

By examination of a large number of stereographs and lenticular stereoscopes, I have found (*Am. Journ. of Science*, November and December, 1881) that in using them, slight axial divergence is very frequently practised. It is nearly always necessary when binocular fusion of images is obtained, in regarding stereographs by voluntarily diminishing the natural convergence of visual axes without the aid of the stereoscope. The assumption of axial convergence, as if in normal vision, is unnecessary and misleading; it should be entirely discarded in explaining vision through the stereoscope. What is really necessary is that the camera axes from corresponding points of the stereograph, at the moment the picture is taken, shall converge; and that these points shall be imaged upon corresponding points of the two retinas. The visual axis may then be either convergent, parallel, or divergent. The visual effect will vary with these conditions, but by no means in accordance with the mathematical formula given above. I have described elsewhere (*Am. Journal of Science*, November and December 1881) a method of determining approximately the apparent position of the object regarded in the stereoscope, rejecting the hypothesis that the visual axis must necessarily converge. It remains to discuss the effect of making the optic angle alternately positive and negative. Helmholtz's conclusion that the only resource, when the visual axes diverge, is to compare the sensation produced with that which it resembles most, is unnecessary. No such resource in the present case would have been needed, even temporarily, had not undue stress been laid upon the convergence of visual lines.

From the fact that a pair of similar images upon corresponding retinal points produce the same impression, as if coming from the same external point, there result two consequences of fundamental importance in binocular vision, on which depends tde explanation of all vision with axial divergence. One is that both eyes are subjectively combined into a single central binocular eye, composed of two eyes coincident in position, each of them receiving its own image, which is wholly or partly superposed on that of the other. This observation is due to Hering (Hering, "Beiträge zur Physiologie," 1861, p. 35-64, or Helmholtz, "Opt. Phys," p. 777), and has been extended and applied by Prof. Le Conte (*Am. Journal of Science*, S. III. vol. i., p. 33, and vol. ii. p. 1, or "Sight," Appleton and Co., New York, 1881, pp. 213-261). The two visual lines terminating on corresponding retinal points are hence subjectively combined into a single median line, to some point of which the binocular image is referred. The apparent position of this point of sight, however, is the result of a judgment, and not a mathematical determination. In normal binocular vision the judgment of distance may accord very nearly with what might be determined by the intersection of visual lines, but there is no necessary coincidence.

The second consequence is that a point farther or nearer than the point of sight is necessarily seen double, because imaged upon retinal points that do not correspond. Conversely, if conjugate points of a stereograph are imaged upon non-corresponding retinal points, fusion can be accomplished only by changing the relation between the visual axes. To the binocular eye, therefore, such points will appear farther or nearer than the point of sight. On these two principles depends, in large measure, the perception of binocular relief.

The perception of relative distance depends upon a variety of conditions, which must be eliminated before binocular perspective is studied. There are then left still three elements to consider:—

1. The optic angle.
2. The focal adjustment of the crystalline lens.
3. The retinal magnitude of the binocular image.

The import of the first of these depends upon the relative degree of tension in the rectus muscles of the eyeballs; of the second on the tension of the ciliary muscle; of the third on the relation between the magnitude and distance of the object. The judgment of distance and size depends upon the acquired skill of the observer in interpreting the sensations due to variation of these elements. This variation is best accomplished with the aid of a modified Wheatstone stereoscope.

Let the stereoscope be so arranged that the visual axis may successively inclose every possible angle between the limits beyond which vision becomes impossible. On its arms let a pair of conjugate pictures be kept at a fixed distance each from its mirror. If the arms be so placed that the optic angle is that of normal vision, the point of sight approximately coincides with the optic vertex, and to the distance of this the focal adjustment is adapted.

Let α = optic angle, varied by means of the stereoscope.
,, α' = optic angle of normal vision for given distance.
,, D = distance of optic vertex from each eye, determined by the formula, $D = \frac{1}{2} i \operatorname{cosec} \frac{1}{2}\alpha$.
,, D′ = distance of radial point measured in the direction from which the reflected ray enters the eye. It is hence the distance of the virtual image in normal vision.
,, A = distance of point of sight from binocular eye.

Under the conditions given above we have—

$\alpha = \alpha'$, and $A = D = D'$. Assume $D' = 50$ cm., then $\alpha' = 7° 20'$.

If now we make $\alpha = 37° 20'$, we have $D = 10$ cm. But to secure distinct vision, the focal adjustment must be adapted to D′, and therefore dissociated from the axial adjustment. This to some extent antagonises the effect of tension of the internal rectus muscles, and this antagonism is increased by the fact that the visual angle remains constant. The combined effect is that $A > D$ but $A < D'$. The apparent size of the image is diminished in the ratio of A to D′. The effect of increasing the optic angle is hence to make the image appear nearer, smaller, and less deep in proportion to its area, but more distant nevertheless than the new optic vertex.

If now we make $\alpha = -5°$, we have $D = -73·4$ cm., but the relaxation of the internal rectus and contraction of the external rectus muscles causes the image to appear to recede in a positive direction. This illusion is opposed by the constancy of the visual angle, and the ciliary effort to keep the focal adjustment adapted to D′. The result is that $A > D'$, and the apparent size of the image is enlarged in the same ratio, while its depth is increased still more. The effect of making the optic angle negative is hence to cause the image to appear farther, larger, and deeper in proportion to its area.

If in the discussion just given we make α the angle between a pair of camera axes, and D the distance of its vertex, while i is the distance between the two lenses, the formula is readily applicable, but α can have only positive values. The optic angle for the observer while using the stereoscope is not necessarily, or even generally, the same as that between the camera axes when the picture was taken. Apparent distance in the stereoscope is thus not determined by the intersection of the observer's visual lines, and no mathematical formula can be made to apply to the interpretation of muscular tension in the muscles of the eyes. The error into which Wheatstone fell, and which was repeated and emphasised by Brewster, consists in the application of geometry where physiological conditions are such as to destroy the value of all geometric constructions. Unfortunately this error is still repeated in most of our text-books of physics, wherever diagrams are employed to explain the theory of the stereoscope.

W. LE CONTE STEVENS

New York

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science for April, 1882, contains—Pringsheim's researches on chlorophyll, translated and condensed by Professor Bayley Balfour (with plates 8 and 9).—Dr. D. H. Scott, on the development of articulated laticiferous vessels (plate 10). In the plants investigated, the vessels arose from rows of cells, of which the cross walls, and where two were in contact, the side walls in part became gradually absorbed. This took place very early; when not in contact, connection took place by means of cross rows of cells, which underwent fusion, or by inoculating outgrowths, before absorption; such cells showed the probable presence of latex.—Dr. E. Klein, on the lymphatic system and the minute structure of the salivary glands and pancreas (plates 11 and 12).—Prof. F. M. Balfour and F. Deighton, a renewed study of the germinal layers of the chick (plates 13–15).—Isao J. Iijima, on the origin and growth of the eggs and egg-strings in Nephelis, with some observations on the "spiral asters" (plates 16–19).—Dr. A. A. Hubrecht, a contribution to the morphology of the Amphineura.—Prof. E. Ray Lankester, on the chlorophyll-corpuscles and amyloid deposits of Spongilla and Hydra (plate 20). These forms are not of the nature of parasitic bodies, but they correspond in structure with the chlorophyll bodies in plants.

Journal of the Royal Microscopical Society for April, 1882, contains the President's address, by Prof. B. Martin Duncan.—On mounting objects in phosphorus, and in a solution of biniodide of mercury and iodide of potassium, by J. W. Stephenson.—On the threads of spider webs, by Dr. J. Anthony.—With the usual most useful summary of current researches relating to geology and botany, and the Proceedings of the Society.

Journal of Anatomy and Physiology, Normal and Pathological, vol. xvi. Part 3, April, 1882, contains—Dr. A. M. Marshall, the segmental value of the cranial nerves (pl. 10).—Dr. G. E. Dobson, the anatomy of *Microgale longicauda*, with remarks on the homologies of the long flexors of the toes in mammalia.—Dr. T. P. A. Stuart, the curled hair and curled hair follicles of the Negro.—Dr. G. Sims Woodhead, some of the pathological conditions of the medulla oblongata, in a case of locomotor ataxia (pl. 11).—Dr. M. Hay, on the action of saline cathartics.—W. J. Walsham, abnormal origin and distribution of the upper seven right intercostal arteries, with remarks.—Dr. W. Stirling, on the digestion of blood by the common leech, and on the formation hæmoglobin crystals (pl. 12).—Prof. Turner, on a specimen of *Mesoplodon bidens*, captured in Shetland; and on a specimen of *Balænoptera borealis*, or *laticeps*, captured in the Firth of Forth.—G. S. Shattock, note on the anatomy of the Thyro-arytenoid muscle in the human larynx.

Johns Hopkins University. Studies from the Biological Laboratory, vol. ii. No. 2 (March, 1882), contains: W. K. Brooks, Medusæ found at Beaufort, N.C., during the summers of 1880 and 1881, and on the development of the ova in Salpa.—J. P. McMurrich, on—the origin of the so-called "test cells" in the Ascidian ovum.—G. M. Sternberg, bacterial organisms commonly found on exposed mucous surfaces and in the alimentary canal of healthy persons;—on a fatal form of Septicæmia in the rabbit from the subcutaneous injection of human saliva;—on experiments with disinfectants.—H. N. Martin, observations on the direct influence of variations of arterial pressure upon the rate of beat of the mammalian heart.—W. H. Howel and M. Warfield, the influences of changes of arterial pressure upon the pulse rate in the Frog and the Terrapin.—H. Garman and B. P. Colton, notes on the development of *Arbacia pustulata*.—K. Mitsukuri, on the structure and significance of some aberrant forms of lamellibranchiate gills.—E. B. Wilson, on the early developmental stages of some polychætous annelides.

The American Naturalist for April, 1882, contains—On mound pipes, by E. A. Barber.—On the flowers of *Solanum rostratum* and *Cassia chamæcrista*, by J. E. Todd.—Is Limulus an arachnid? by A. S. Packard; a criticism on the views of Prof. Lankester.—On a pathogenic Schizophyte of the hog, by H. J. Detmers.—On Mexican caves with human remains, by Ed. Palmer.—The Editor's table.—Recent literature.—General notes, and scientific news.

May, 1882, contains—The acorn-storing habits of the Californian woodpecker, by R. E. C. Stearns.—Observations on some American forms of *Chara coronata*, by T. F. Allen.—The löess of North America, by R. Ellsworth Call.—The ichthyological papers of G. P. Dunbar, with a sketch of his life by J. L. Wortman.—Problems for zoologists, by J. G. Kingsley.—Recent literature.—General Notes.—Scientific news.

Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien, Bd. xxi. Heft 2, 1882, contains: Josef Mik, dipterological studies, II. (pl. xvi.), and notes on G. Strobl's discoveries of Diptera at Seitenstetten.—Ed. Ritter, on the Pselaphidæ and Scydmaenidæ of Syria; analytic key to the European Coleoptera, V. (pl. xix.).—C. R. Osten-Sacken, list of the entomological writings of Rondani (supplementary to Hagen).—J. Freyn, supplement to the flora of South Istria.—H. B. Möschler, contributions to the butterfly fauna of Surinam, IV. and end (pls. xvii. and xviii.).—A. Rogenhofer and Dr. R. W. v. Dalla Torre, on the Hymenoptera of Scopoli's "Entomologica Carniolica."—August Pelzeln, on the second package of birds sent by Dr. E. Bey from Central Africa.—Dr. L. W. Schaufuss, zoological results of an excursion to the Balearic Islands (pl. xxi.).—Dr. L. Koch, the Arachnida and Myriopoda of the Balearics (pl. xx. and xxi.).—Schulzer v. Müggenburg, mycological notes, VI.—L. Ganglbauer, analytic tables of European Coleoptera (pl. xxii.).—A. B. Meyer, on birds from some of the southern islands of the Malay Archipelago.—Johann Bubela, list of the wild plants of Bisenz in Moravia.

Archives des Sciences Physiques et Naturelles, April 15.—The grain of the glacier, by F. A. Forel.—Note on the extension of a property of gases to liquids and to solids, by C. Cellèrier.—Recent changes in the appearances of Jupiter, by E. Gautier.

Atti della R. Accademia dei Lincei, vol. vi. fasc. 8.—Observations on the topography of the planet Mars, by G. Schiaparelli.—Communication on a geyser discovered at Montrond (Loire), by F. Lauri.—On the same subject, by F. Keller.—On the embryo of *Cuphea*, by G. Briosi.—Influence of different electric resistances on the dimensions of the excitative spark of condensers, by E. Villari.—On the dynamical value of a calorie, by G. Cantoni and G. Gerosa.—Oxidation of titanic acid, by A. Piccini.—Reports.

Morphologisches Jahrbuch. Eine Zeitschrift für Anatomie und Entwickelungsgeschichte, Bd 7, Heft iv., 1882, contains—Dr. Hans Virchow, on the lens and retinal vessels of the eel (pl. 27).—Dr. Sigbert Ganser, comparative anatomy studies of the brain of the mole, pp. 590, 725 (plates 28-32.—A most minute and painstaking account of the mole's brain), Dr. W. Pfitzner.—On nerve-endings in epithelium (pl. 33).

SOCIETIES AND ACADEMIES

London

Mathematical Society, May 11.—S. Roberts, F.R.S., president, in the chair.—Mr. A. L. Daniels was elected a Member.—Dr. Hirst, F.R.S., communicated an account (similar to that he had given before the Royal Society in the afternoon of the same day) of a paper by M. Vanecek entitled "Sur l'Inversion générale."—The following further communications were made:—Elementary analytical proof of Graves's and MacCullagh's theorems, with an extension of the former, by J. Griffiths.—Note on a system of confocal bicircular quartics, by R. A. Roberts.—On the vibrations of an elastic sphere, by Prof. Lamb.—On a formula relating to elliptic integrals of the third kind, by Prof. Cayley, F.R.S.; and a short note by the president.

Physical Society, May 6.—Prof. Clifton, president, in the chair.—New Member, Mr. W. H. Heaton.—Mr. Lecky described a form of battery arranged by Mr. A. R. Bennet, of Glasgow, at a cost of *6d.* per cell. The vessel and electro-negative plate consists of an iron meat or milk tin, into which is placed a porous pot containing a zinc plate stuck in a paraffined cork cover, fitting the porous pot. A solution of caustic soda is the liquid. In it iron does not rust, and is electro-negative to zinc. The electromotive force is 1·23 volts where the Daniel is taken as 1 volt and the Leclanché as 1·30 volts. Iron filings round the iron plate facilitate depolarisation by the escape of hydrogen from their points. The cell pitted against a Leclanché was found to ring an electric bell even longer than the latter.—Prof. Guthrie (in the absence of Dr. F. D. Brown, the author) gave a summary of a paper entitled "Notes on Thermometry." This described a method of calibrating the tubes by means of a microscope having an extra half-lens before the object-glass, which focussed the end of the mercury column, whilst the other lens focussed the tube, so that no alteration of the focus of the microscope was necessary in making an observation. Dr. Brown also found that a constant zero temperature was better obtained from a mixture of ice and water than from drained ice; and that it was preferable to mix the ice with distilled water rather than ordinary water. Acting on the suggestion of Dr. Guthrie, Dr. Whipple, of Kew, had found that the ice itself might be from different sources without appreciably affecting the result. Dr. Whipple called attention to the change of zero in thermometers by heating, and recommended buyers to see that makers had not let them be heated after their calibration. Mr. J. Macfarlane Gray suggested that the thermometers used by Regnault should be examined now, as our standards are based on his results. Prof. Clifton pointed out that the half-lens in the microscope would probably distort the image of the mercury column.—Prof. Guthrie then read a paper on the repulsion of a suspended horseshoe magnet by a rotating copper disc below it. He gave tables of quantitative results and a plotted curve, showing that the repulsion varied on the square of the rate of rotation. For a surface velocity of the disc of 163 metres per minute the repulsion was ·41 grammes.

Anthropological Institute, May 9, Major-General Pitt Rivers, F.R.S., president, in the chair.—The election of Mr. Henry Ling Roth was announced. Mr. G. M. Atkinson made some remarks upon a palæolithic implement found eighteen feet below the bed of the Thames at Chelsea, and exhibited by Mr. Lambton Young, C.E., and a jet ornament from Garvagh, co. Londonderry, exhibited by Mr. A. G. Geoghegan.—Mr. Worthington G. Smith exhibited a series of large palæolithic implements recently discovered.—Dr. Beddoe, F.R.S., read a paper on the evidence of surnames as to ethnological changes in England. The discussion was sustained by Messrs. Hyde Clarke, Holt, Park Harrison, Prideaux, Atkinson, C. Roberts and the chairman.—Mr. Park Harrison, M.A., read a paper on the survival of certain racial features in the population of the British Isles at the present day. Dr. Beddoe, Prof. Thane, Mr. Atkinson, and the president joined in the discussion.

Institution of Civil Engineers, May 9.—Sir Frederick Bramwell, vice-president, in the chair.—The paper read was on "Coal Washing," by Mr. Thos. F. Harvey, Assoc. M. Inst. C.E.

Royal Horticultural Society, May 9.—Sir J. D. Hooker in the chair.—*Larches attacked by Larvæ:* From a communication received by Sir J. D. Hooker it would appear that the trees mentioned in the last report had suffered much more extensively than was supposed, whole trees having been stripped of their foliage.—*Fungus in Dilute Sulphuric Acid:* Mr. W. G. Smith exhibited a specimen of the vinegar fungus, *Penicillium crustaceum*, growing in dilute sulphuric acid. Sir J. D. Hooker suggested it should be ascertained what nitrogenous substance was present in the acid, which alone could not support life.—*Proliferous Mushroom:* He also exhibited a specimen in which one pileus was inverted and adherent to the summit of another mushroom growing in the ordinary way.—*Foliage Injured by the Gale:* Dr. M. T. Masters exhibited leaves injured in various ways by the late severe gale, which by destroying the growing parts only revealed the different developmental orders of leaves. It appeared that salt spray had injured trees in some cases; but it was thought that the duration and great cold of the wind was more generally the cause of injury. Beeches, it was noticed, withstood it better than oaks.

Victoria (Philosophical) Institute.—A paper was read by Prof. Lionel S. Beale, F.R.S., on "Dictatorial and Scientific Utterances and the Decline of Thought." The author tried to show that the opinion now generally entertained by scientific men that the phenomena of the living world are due to the properties of the material particles is erroneous.

Berlin

Physiological Society, May 5.—Prof. du Bois Reymond, president, in the chair.—Dr. J. Sander read a paper upon the distribution of the vaso-motor nerve-centres. In addition to the well-known centre of the vaso-motor nerves in the medulla-oblongata, several other centres in the spinal chord were determined by the experiments that were made. In the case of each of these centres the degree of stimulation was determined which produced the greatest effect, and beyond which no further excitation produced a rise in the blood-pressure. If this degree of maximum excitation was not reached, a cumulative effect was perceived by the simultaneous stimulation of two vaso-motor centres, and the weak excitation of two centres had always a much greater effect than that which would have been expected to result from the degree of stimulation. The increased blood-pressure that resulted from the stimulation of the centre lasted for a prolonged period, which proves that the smooth muscular tissue of the walls of the blood-vessels does not tire quickly.—In a previous meeting of the Society held on March 29, Dr. R. Koch had demonstrated his important discovery that tuberculosis is a parasitic disease, that its occurrence is connected with the presence of tubercle Bacillæ, which are always found in those tissues which had undergone tubercular change. The Bacillæ can be isolated and can be cultivated for long periods quite isolated; animals that were infected with the isolated bacteria by very different methods became, without exception, affected with tuberculosis. The important demonstration of these tubercle Bacillæ was accomplished by Dr. Koch by a staining method which consisted in the employment of an alkaline solution of methyl-blue and a watery Vesuvian solution (*Vesuvialösung*); under this treatment all tissues and cells became stained brown, while the tubercle Bacillæ alone became stained blue; by this means it was easy to demonstrate the tubercle Bacillæ in the excreta of consumptive patients, in which they regularly occur. This interesting relation of the tubercle-Bacillæ to the staining-fluids has been made the subject of investigation by Dr. Ehrlich, the principal results of which may be condensed into the statement that the cause of this extraordinary appearance lies in the particular properties of the ectoderm of the tubercle-Bacillæ, which is penetrable by alkaline fluids, and therefore also for alkaline methyl-blue, whereas it is impenetrable by neutral substances, and especially by acids. Even the application of the strongest mineral acids, such as sulphuric acid, nitric acid, and such like, produced no effect on the Bacillæ. This peculiarity of the tubercle-Bacillæ has, besides its scientific, also, a remarkable practical importance, as it teaches that no acid fluids are to be used in disinfection, or for the purpose of killing tubercle-Bacillæ, as their ectoderm is impenetrable by such, but that alkaline-solutions are to be used, as they become easily diffused into the interior and destroy the Bacillæ.—Prof. Baumann reported on the examination of two pieces of a Termite's nest, which Prof. Renlau had brought from Australia. The one piece was taken from the outer wall of a structure that was apparently inhabited by ants; the second came from the inner structure of the nest. The first was free from organic matter, and consisted almost entirely of clay containing iron; the second was of a brownish-colour, perforated in all directions with numerous passages, and consisted almost entirely of organic material. While the most careful microscopical examination did not reveal any trace of an organic structure, still on the other band a chemical analysis showed a chemical composition very like that of most woods. Both the proportion of carbon and the amount and composition of the ash showed that this structureless substance is most nearly allied to wood. Mr. Baumann, consequently, looked for cellulose in the wall of the nest, and found it present in large quantities, so that there hardly remained a shadow of doubt but that the mass was derived from wood. The specific gravity was found to be 1·36, *i.e.* greater than that of the heaviest woods. The other constituents of this substance, which consisted of 97 per cent. of organic materials, afforded no assistance in the solution of the question as to whether this structureless mass had been formed out of wood, or as to how it had been manufactured by the animals.

PARIS

Academy of Sciences, May 8.—M. Jamin in the chair.—The following papers were read:—On the effects produced in vacuum by the current of Gramme machines, by MM. Jamin and Maneuvrièr. In an electric egg, with carbons (vacuum about 12mm.), a phenomenon like that of Geissler tubes is produced by the two currents, which contribute equally; but it is much more brilliant; the carbons soon get heated to a pale white throughout, and volatilised, giving a blue vapour, which condenses, and makes the egg opaque. This volatilisation was mostly avoided, in another case, by using two groups of carbons (instead of the pair) diverging from the rheophores towards each other, cone-wise. A large number of *effluves* here take the place of one. Still brighter effects were had with copper rods so arranged.—General considerations on preventers of fire, or pyroscopes, by M. Ledieu. After noting the faults of some methods, he indicates a system in which a cylinder of strong insulating material, holding a liquid which is refractory to electrolysation, and has good conductivity, increasing decidedly with temperature, is interposed in a single circuit, a platinum rheophore entering the liquid at either end. Absolute alcohol is a suitable liquid.—M. de Freycinet was elected Free Member in place of the late M. Bussy.—Report on a memoir relating to albuminoid matters, was presented to the Academy by M. Béchamp. The author has determined the rotatory power of a large number of these matters, and given elementary analyses of the best characterised species. The power, which fibrine has, of decomposing oxygenated water, resides, M. Béchamp proves, in the granular substance (albuminoid), left as an insoluble residue, on treatment of fibrine with weak hydrochloric acid. Raised to boiling in water, this loses its power. Again, M. Béchamp shows that it is a property of all albuminoid matters (as of albumen), that their oxidation by means of permanganate of potash furnishes a certain quantity of urea.—Report of the Commission charged to examine the work presented by Rear Admiral Serre "On the Athenian Trireme."—Researches on one of the principal bases of doctrines relative to the mechanism of production of voluntary movements and convulsions, by M. Brown-Séquard. It must be allowed that the excitomotor zone of the cerebral surface and of all excitable parts of the brain can set in motion the limbs of the corresponding side like those of the opposite side, and this after transverse section of a lateral half of the bridge of Varoli, the bulb, or the cervical cord, or even after two sections—one of the right, the other of the left half of the base of the brain—provided there is a certain interval between the sections.—On the winter egg of phylloxera, by M. Henneguy.—On the spherical representation of surfaces, by M. Darboux.—On the tides of Campbell's Island, by M. Bouquet de la Grye. *Inter alia*, the retardation of the tide is twenty-four hours.—Remarks on the velocity of light, on the occasion of two memoirs of Lord Rayleigh, by M. Gouy. Both appear to have come to the same conclusions and formulæ independently. M. Gouy obtains the result (among others) that *perfectly homogeneous* light is necessarily formed of an indefinite series of equal waves, without perturbations or irregularities of any sort.—On the depression of the zero point in mercury thermometers, by M. Crafts. The greater the interval between the temperature that has produced a depression, and that at which the thermometer is kept to raise it again, the slower is the movement, and it may be incomplete if the interval considerably exceeds 100°. M. Crafts gives a table by which the depressions through heating Paris thermometers may be estimated.—On the polarisation of electrodes and the conductivity of liquids (continued), by M. Bouty. He results obtained by the method previously indicated. He gives extends to the case of mixtures M. Berthelot's law for that of simple electrolytes.—Magnetic variations of magnetised bars during thunderstorms, by M. de Lalagade. With a thin iron membrane mounted, as in a telephone, at the end of a magnetised steel bar, he heard a small dry sound at each lightning-flash. Better effects were had with twelve horizontal magnets, each having twelve coils at one end, the wires connected with two conductors and two telephones. Sounds were heard before as well as during each flash.—On a balloon ascent at Paris on May 7, 1882, by M. Eloy. Starting about midday they rose 300 m. in a south east current, then to 1400 m. in a north-east one, above which a south-east current was met with again. Up to 1400 m. the average fall of temperature was 1° for 100 m., but at 1900 m. (the highest point reached), the thermometer was above the indication at 1400°.—On the composition and the equivalent in volume of pernitric acid, by MM. Hautefeuille and Chappuis. The formula NO_6 is arrived at.—Action of potash on oxide of lead, by M. Ditte.—On phosphate of chromium, and its utilisation in chemical analysis and industry, by M. Carnot.—Studies on the photo-chemical reaction of peroxalate of iron, by M. Jodin. For several years he has used the substance in experiments on plant-physiology, to supply CO_2 to plants by decomposition in light. The quantity liberated varies considerably with the composition of the solutions.—On new carbo-siliciated compounds, by M. Colson.—On homologous and isomeric rosanilines, by MM. Rosenstiehl and Gerber.—Chemical composition of the ash thrown out by Vesuvius on February 25, 1882, by M. Ricciardi.—Study on the antiseptic properties of salicylic acid, by MM. Robinet and Pellet. They describe experiments with salicylised must, showing that beyond 0·3 gr. per litre, salicylic acid is a powerful antiseptic, and that at 1 gr. it destroys even the action of yeast.—A claim of priority, in the idea of the photographic gun, was put in for M. Leblond.

CONTENTS

THURSDAY, MAY 25, 1882

CHARLES DARWIN[1]

II.

NO man of his time has exercised upon the science of Geology a profounder influence than Charles Darwin. At an early period he took much interest in geological studies, and all through life, while engaged in other pursuits, he kept himself acquainted with the progress that was being made in this department of natural knowledge. His influence upon it has been twofold. It arises partly from the importance and originality of some of his own contributions to the literature of the science, but chiefly from the bearing of his work on other branches of natural history.

When he began to direct his attention to geological inquiry the sway of the Cataclysmal school of geology was still paramount. But already the Uniformitarians were gathering strength and, before many years were past, had ranged themselves under the banner of their great champion Lyell. Darwin, who always recognised his indebtedness to Lyell's teaching, gave a powerful impulse to its general reception by the way in which he gathered from all parts of the world facts in its support. He continually sought in the phenomena of the present time the explanation of those of the past. Yet he was all the while laying the foundation on which the later or Evolutional school of geology has been built up.

Darwin's specially geological memoirs are not numerous, nor have they been of the same epoch-making kind as his biological researches. But every one of them bears the stamp of his marvellous acuteness in observation, his sagacity in grouping scattered facts, and his unrivalled far-reaching vision that commanded all their mutual bearings, as well as their place in the general economy of things. His long travels in the *Beagle* afforded him opportunities of making himself acquainted with geological phenomena of the most varied kinds. With the exception of one or two minor papers written in later years, it may be said that all his direct contributions to geology arose out of the *Beagle* voyage. The largest and most important part of his geological work dealt with the hypogene forces of nature—those that are concerned in volcanoes and earthquakes, in the elevation of mountains and continents, in the subsidence of vast areas of the sea-bottom, and in the crumpling, foliation, and cleavage of the rocks of the earth's crust. His researches in these subjects were mainly embodied in the "Geology of the Voyage of the *Beagle*"—a work which, in three successive parts, was published under the auspices of the Lords of the Treasury.

The order chosen by Darwin for the subjects of these three parts probably indicates the relative importance with which they were regarded by himself. The first was entitled "The Structure and Distribution of Coral Reefs" (1842). This well-known treatise, the most original of all its author's geological memoirs, has become one of the recognised classics of geological literature. The origin of those remarkable rings of coral-rock in mid-ocean had given rise to much speculation, but no satisfactory solution of the problem had been proposed. After visiting many of them, and examining also coral-reefs fringing islands and continents, he offered a theory which for simplicity and grandeur strikes every reader with astonishment. It is pleasant after the lapse of many years to recall the delight with which one first read the "Coral Reefs," how one watched the facts being marshalled into their places, nothing being ignored or passed lightly over, and how step by step one was led up to the grand conclusion of wide oceanic subsidence. No more admirable example of scientific method was ever given to the world, and even if he had written nothing else, this treatise alone would have placed Darwin in the very front of investigators of nature.

The second part was entitled "Geological Observations on the Volcanic Islands visited during the voyage of H.M.S. *Beagle*, together with some brief notices on the geology of Australia and the Cape of Good Hope" (1844). Full of detailed observations, this work still remains the best authority on the general structure of most of the regions it describes. At the time it was written, the "Crater of elevation theory," though opposed by Constant Prevost, Scrope, and Lyell, was generally accepted, at least on the Continent. Darwin, however, could not receive it as a valid explanation of the facts, and though he did not adopt the views of its chief opponents, but ventured to propose a hypothesis of his own, the observations impartially made and described by him in this volume must be regarded as having contributed towards the final solution of the question.

The third and concluding part bore the title of "Geological Observations on South America" (1846). In this work the author embodied all the materials collected by him for the illustration of South American geology save some which had already been published elsewhere. One of the most important features of the book was the evidence which it brought forward to prove the slow, interrupted elevation of the South American continent during a recent geological period. On the western sea-board he showed that beds of marine shells could be traced more or less continuously for a distance of upwards of 2000 miles, that the elevation had been unequal, reaching in some places at least to as much as 1300 feet, that in one instance at a height of 85 feet above the sea, undoubted traces of the presence of man occurred in a raised-beach, and hence that the land had there risen 85 feet since Indian man had inhabited Peru. These proofs of recent elevation may have influenced him in the conclusion which he drew as to the marine origin of the great elevated plains of Chili. But at that time, there was a general tendency among British geologists to detect evidence of sea-action everywhere and to ignore or minimise the action of running water upon the land. An important chapter of the volume, devoted to a discussion of the phenomena of cleavage and foliation, is well known to every student of the literature of metamorphism.

The official records of the *Beagle* did not, however, include all that Darwin wrote on the geology of the voyage. He contributed to the *Transactions* of the Geological Society (vol. v. 1840) a paper on the connection of volcanic phenomena. In the same publication (vi. 1842) appears another, on the erratic boulders of South

---

[1] Continued from p. 51.

America; while a third, on the geology of the Falkland Islands, was published later.

While dealing with the subterranean agents in geological change, he kept at the same time an ever watchful eye upon the superficial operations by which the surface of the globe is modified. He is one of the earliest writers to recognise the magnitude of the denudation to which even recent geological accumulations have been subjected. One of the most impressive lessons to be learnt from his account of Volcanic Islands is the prodigious extent to which they have been denuded. As just stated he was disposed to attribute more of this work to the action of the sea than most geologists would now admit; but he lived himself to modify his original views, and on this subject his latest utterances are quite abreast of the time. It is interesting to note that one of his early geological papers was on the Formation of Mould (1840), and that after the lapse of forty years he returned to this subject, devoting to it the last of his volumes. In the first sketch we see the patient observation and shrewdness of inference so eminently characteristic of the writer, and in the finished work (so recently noticed in these columns) the same faculties enriched with the experience of a long and busy life. In bringing to light the operations of the earthworm, he called the attention of geologists to an agency, the real efficiency of which they probably do not yet appreciate. Élie de Beaumont looked upon the layer of grass-covered soil as a permanent datum-line from which the denudation of exposed surfaces might be measured. But, as Darwin showed, the constant transference of soil from beneath to the surface, and the consequent exposure of the materials so transferred to be dried and blown away by wind, or to be washed to lower levels by rain, must tend slowly but certainly to lower the level even of undisturbed grass-covered land.

To another of his early papers reference may be made, from its interest in the history of British geology. Buckland, following in the footsteps of Agassiz, had initiated that prodigious amount of literature which has now been devoted to the records of the Glacial period in this country, by reading to the Geological Society a paper "On Diluvio-glacial Phenomena in Snowdonia and in Adjacent Parts of North Wales" (1841). Darwin, whose wanderings in South America had led him to reflect deeply upon the problems presented by erratic blocks, took an early opportunity of visiting the Welsh district described by Buckland, and at once declared himself to be a believer in the former presence of glaciers in Britain. His paper (1843) in which this belief is stated and enforced by additional observations, stands almost at the top of the long list of English contributions to the history of the Ice Age.

The influence exercised upon the progress of geology by Darwin's researches in other than geological fields, is less easy to be appraised. Yet it has been far more widespread and profound than that of his direct geological work. Even as far back as the time of the voyage of the *Beagle*, he had been led to reflect deeply on some of Lyell's speculations upon the influence of geological changes on the geographical distribution of animals. From that time the intimate connection between geological history and biological progress seems to have been continually present in his mind. It was not, however, until the appearance of the "Origin of Species" in 1859 that the full import of his reflections was perceived. His chapter on the "Imperfection of the Geological Record" startled geologists as from a profound slumber. It would be incorrect to say that he was the first to recognise the incompleteness of the record; but certainly until the appearance of that famous chapter the general body of geologists was blissfully unconscious of how incredibly fragmentary the geological record really is. Darwin showed why this must necessarily be the case; how multitudes of organic types, both of the sea and of the land, must have decayed and never have been preserved in any geological deposit; how, even if entombed in such accumulations, they would in great measure be dissolved away by the subsequent percolation of water. Returning to some of his early speculations he pointed out that massive geological deposits rich in fossils, could only have been laid down during subsidence, and only where the supply of sediment was sufficient to let the sea remain shallow, and to entomb the organic remains on its floor before they had decayed. Hence, by the very conditions of its formation, the geological record, instead of being a continuous and tolerably complete chronicle, must almost necessarily be intermittent and fragmentary. The sudden appearance of whole groups of allied species of fossils on certain horizons had been assumed by some eminent authorities as a fatal objection to any doctrine of the transmutation of species. But Darwin now claimed this fact as only another evidence of the enormous gaps in geological history. Reiterating again and again that only a small fraction of the world had been examined geologically and that even that fraction was still but imperfectly known, he called attention to the history of geological discovery as furnishing itself a strong argument against those who argued as if the geological record were a full chronicle of the history of life upon the earth. There is a natural tendency to look upon the horizon upon which a fossil species first appears as marking its birth, and that on which it finally disappears as indicating its extinction. Darwin declared this assumption to be "rash in the extreme." No palæontologist nor geologist will now gainsay this assertion. And yet how continually do we still hear men talking of the stages of the geological record, as if these were sharply marked off everywhere by the first appearance and final disappearance of certain species. The boldness with which Darwin challenged some of these long-rooted beliefs is not less conspicuous than the modesty and deference with which his own suggestions were always given. "It is notorious," he remarked, "on what excessively slight differences many palæontologists have founded their species; and they do this the more readily if the specimens come from different sub-stages of the same formation."

Starting from this conception of the nature of the geological record, Darwin could show that the leading facts made known by palæontology could be explained by his theory of descent with modification through natural selection. New species had slowly come in, as old ones had slowly died out. Once the thread of succession had been broken it was never taken up again; an extinct species or group never reappeared, yet extinction was a slow and unequal process, and a few descendants of ancient types might be found lingering in protected and isolated situations. "We can understand how it is that all the forms of life, ancient and recent, make together one grand system; for all are connected by generation. From the continued tendency to divergence, the more ancient a form, is the more generally it differs from those now living. The inhabitants of each successive period in the world's history have beaten their predecessors in the race for life, and are in so far, higher in the scale of nature; and this may account for that vague, yet ill-defined sentiment, felt by many palæontologists, that organisation on the whole has progressed. If it should hereafter be proved that ancient animals resemble to a certain extent the embryos of more recent animals of the same class, this fact will be intelligible."

Again, what a flood of fresh light was poured upon geological inquiry by the two chapters on Geographical Distribution in the "Origin of Species!" A new field of research, or, at least, one in which comparatively little had been yet attempted, was there opened out. The grouping of living organisms over the globe was now seen to have the most momentous geological bearings. Every species of plant and animal must have had a geological history, and might be made to tell its story of the changes of land and sea.

In fine, the spirit of Mr. Darwin's teaching may be traced all through the literature of science, even in departments which he never himself entered. No branch of research has benefited more from the infusion of this spirit than geology. Time-honoured prejudices have been broken down, theories that seemed the most surely based have been reconsidered, and, when found untenable, have been boldly discarded. That the Present must be taken as a guide to the Past, has been more fearlessly asserted than ever. And yet it has been recognised that the present differs widely from the past, that there has been a progress everywhere, that Evolution and not Uniformitarianism has been the law by which geological history has been governed. For the impetus with which these views have been advanced in every civilised country, we look up with reverence to the loved and immortal name of Charles Darwin.

(*To be continued.*)

THE TOTAL ECLIPSE

THE Special Correspondent of the *Daily News* with the English Eclipse Expedition telegraphs as follows under date, Sohag, May 17:—

This eventful morning was the finest we have yet had, cool and without a cloud. A great crowd of natives in picturesque costumes lined the road and the hill between the camp and Sohag. The shore of the Nile, except before the observatories, was packed with dahabeeahs bringing the governors of the provinces and other notables to observe the eclipse and do honour to the strangers. Thanks to Moktar Bey, in charge of the camp, and a force of soldiery, there was no confusion. Along a line of 300 yards the French, English, and Italian observers were left in undisturbed possession of tents and observatories. Nevertheless, while the sky darkened and assumed a leaden hue, the hills bounding the Nile bathed in purple, the great silence gave way, and from river and palm-shaded slope arose a shout of wonder and fear, which reached its climax at the moment of the sun's disappearance; nor ceased then, for, in addition to the horror of an eclipse—which the natives here as in India, attribute to the act of a dragon—there appeared in the heavens on the right of the sun an unmistakable scimetar. The eclipse had, in fact, revealed the existence of a new comet. Despite the short totality, many valuable results have been obtained. I am permitted to send a copy of the collective telegram sent to the various Governments, showing many new facts touching the sun's atmosphere; though matters have not become much simpler, which means more work. The layer to which much absorption has been ascribed seems vanishing from existence. The band K in the spectrum of the corona fully explains the eclipse colouring. The collective note is as follows:—

"Unprecedented facilities have been accorded by the Egyptian Government for the observation of the eclipse. A plan was agreed upon between the English, French, and Italian expeditions. Among the results, the most satisfactory are photographs of the corona, and a complete spectrum obtained by Schuster on Abney's plates. H and K are the most intense lines. A study of the red end of the spectrum of corona and protuberances was made by Tacchini. A comet near the sun was a striking object; it was photographed and observed by the naked eye. Bright lines were observed before and after totality at different heights by Lockyer, with intensities differing from Fraunhofer's lines; by Lockyer and Trépied an absolute determination was made of the place of the coronal line 1474 in Kirchhoff's scale; by Thollon and Trépied the absence of dark lines from the coronal spectrum was noted. Tacchini and Thollon, with very different dispersions, noted many bright lines in the violet. Thollon observed spectrum of the corona, and Schuster photographed it. The hydrogen and coronal line were studied in the grating spectroscope by Buisieux, and with direct vision prism by Thollon. Rings were observed in the grating by Lockyer, of the first, second, and third order. The continuous spectrum is fainter than 1878, stronger than 1871. An intensification of the absorption lines was observed in group B, at moon's edge, by Trépied and Thollon.—(Signed), LOCKYER, TACCHINI, and THOLLON."

When our cases are packed, we shall start directly home.

Captain Abney writes as follows to the *Photographic News*:—

I have received a brief telegram from Egypt regarding the Eclipse Expedition, and as it is in cipher I give the gist of the news. "Very successful all round. The whole of the spectrum with blue lines on a continuous background has been photographed. Prominences photographed with the prismatic camera (showing, of course, ring spectrum). Three photographs taken of the corona. A comet close to sun photographed with the prismatic and also ordinary cameras."

A telegram from the Alexandria correspondent of the *Daily News* states that Mr. Lockyer was to leave for London yesterday by the Peninsular and Oriental Company's steamer *Clyde*, while the other members of the Eclipse Expedition, with their instruments, were to leave next week.

KANT'S CRITIQUE OF PURE REASON

Immanuel Kant's Critique of Pure Reason. In Commemoration of the Centenary of its First Publication. Translated into English by F. Max Müller. With an Historical Introduction by Ludwig Noiré. Two Vols. (London: Macmillan and Co., 1881.)

THE records of science and philosophy during the past few years have been especially fertile in indications of a desire to place the relations of these two departments of inquiry upon a better footing than that of their former history. The desire has its source not in a spirit of concession but in a consciousness of necessity. A deeper criticism of conceptions with which in scientific investigation it is not possible to dispense, has brought several of its chief apostles face to face with fundamental obscurities and even contradictions which seem to cast doubt upon the validity of these conceptions. On the other hand philosophy has of late been coming into extensive contact with results obtained by scientific methods, and has been compelled either to modify its position, or go to the wall. The result is that attention has been increasingly directed to that critical examination of the nature of human knowledge, which claims on its negative side to have finally destroyed the old metaphysics and assigned definite limits to investigation, on its positive side to have exhibited these limits as arising out of the ultimate constitution of mind. The translation, just published, of the "Kritik der reinen Vernunft," is one of the latest contributions to the literature of this subject. The cry of "Back to Kant" which has of late years been heard so frequently in this country and abroad, has been responded to by Prof. Max Müller with two well-appointed volumes. Of these the first contains the translator's preface, an "Historical Introduction" by Prof. Noiré, and a translation of those passages of the second edition of the "Kritik," which differ from the corresponding passages in the first. The second volume consists of the translation of the first edition. The merits of the introductions and translations will be best estimated after the consideration—as far as the compass of a review will allow—of Kant's position.

To understand the critical philosophy, it is essential to realise that its problem and subject-matter are entirely different from any thing that is or can be dealt with by science in the ordinary acceptation of the term, and in particular from the investigations of physiological or other psychology. Science deals with what it is customary in our aspect to call mind, and in another cerebral organisation, and inquires into the relations of this to the surrounding environment. It seeks to lay bare the mechanism of perception and ideation, and to exhibit the complete dependence of mental upon cerebral functions. And of late years it has pretty well justified its title to the exclusive occupation of the field as against the old introspective psychology. Mind and its environment are alike the objects of and given in what may be indifferently spoken of as knowledge, consciousness, or experience. That is to say, they presuppose knowledge (to use the appellation which is perhaps least encumbered with question-begging associations) as that through which, like everything else, they exist, and in which the meaning of existence is to be found. The old Berkeleian reduction of *esse* to *percipi* is matter of common knowledge, and the leaders of scientific thought show a very proper disposition to treat it as a truism. For the statement that the universe in ultimate analysis is reducible to a succession of states or groups of states of consciousness, amounts to no more than the statement that the universe exists, and may be dismissed as outside the region of scientific questions in exactly the same sense as is this assumption. But if the step from Berkeley to Hume be taken, and existence regarded as the "impressions and ideas" of a particular individual, whose consciousness itself exists only so far as it is the object of knowledge, there ensue logical consequences of the gravest description. The inquirer is then confronted with the conclusion that the universe in so far as real is nothing more than an arbitrary sequence of phases of his own mind, as to which there is not the remotest reason for believing that the uniformity of the past will be resembled in the events of the future. Scientific and indeed all propositions, particular as well as general, become a delusion and self-consciousness an unintelligible deception. Since Hume's "Treatise" was published, it has been characteristic of his would-be interpreters, until within the last few years, to misunderstand him, of scientific men to ignore him, and of that succession of distinguished writers who have sought to apply the canons of scientific method to the problems of philosophy, in a somewhat perplexing fashion to do both. Of late the significance of Hume's teaching has been better understood. Men have come to see that if reality consists in ultimate analysis of a succession of sensations which, existing only in so far as they are felt, cannot be connected excepting by a purely subjective process, they must accept the logical consequences that not only is the belief in a uniform constitution of nature no longer tenable, but that the subjective semblance of such a belief is as incapable of being accounted for as the fact itself. This was the teaching of Kant, and those who seek its detailed justification and the proof that Hume did more than show the unreliability of general propositions, will do well to turn to the pages of the late Mr. Green and of Mr. Arthur Balfour. It is characteristic of Kant, that although he grasped the serious and self-destructive character of Hume's conclusion as to the impossibility of knowledge much more fully than its originator, he yet speaks of it as though it were of importance, only because it detracted from the supposed necessary truth of mathematical and causal relations. He has accordingly misled the majority of his critics into the unfortunate idea, that in denying the necessity of these relations, they have displaced the foundation of the critical system. The problem stood thus. It was clear that existence had no meaning except the being perceived by an actually or possibly percipient consciousness; and the only known form of such a consciousness was the individual self. But to say that existence meant the being a mode of the consciousness of the individual self, involved the contradiction of facts by the implicit denial of the possibility of even a semblance of knowledge. There was only one alternative: to recognise that the self in which the meaning of existence was to be sought was not the finite self disclosed in experience—an apparent point in a boundless expanse, from which it was distinguished only by the fact of its being always "here and now," but constructive thought, which was always subject and never object in knowledge, of which it was wrong to predicate existence, because it was above the categories of existence in that only as its object could things be said to be. For Kant, such an intellectual activity was something very different from that "unknowable" of which so much has been written. Of the "unknowable" it may be said, that although it exists, is a cause and so forth, it can never be intelligible to a finite mind, but it is none the less the object as distinguished from the subject of thought.

Kant's (as the time went) great knowledge of physical science no doubt contributed to cause him to revolt keenly against Hume's apotheosis of the individual self. He had anticipated, and to a surprising degree grasped, the modern conception of evolution. He had worked out, independently of Laplace, the mechanical theory of the solar system, and had enunciated the hypothesis of development in the organised world. For him there was no possibility of supernatural interference, and Man was but the last link in a gradually evolved chain of life. He could not assent to conclusions which assigned to an individual consciousness—itself but a point in the boundless immensity of space and time—the position of being the foundation of the whole phenomenal universe, and which regarded knowledge as a fiction. He saw clearly enough that the problem was not an ordinary scientific problem of relations within experience, but the problem as to the constitution of experience itself. In science (as indeed in metaphysics) we are always concerning ourselves with some conceivable object of knowledge, and we assume that there is no question about the conditions of that experience in which that object is actually or conceivably included as a part. But Kant's problem was that of knowledge itself, with the relations of space, time, causality, &c., which enter into its constitution, and which, as the conditions of the possibility of objects of knowledge could bear themselves, are implied in such objects. His method was that which is the general method of inductive reasoning, to apply an hypothesis to certain data, and to modify it, as appeared necessary from the result of the test of adequacy to the explanation of these data. His findings were in outline these: Berkeley and Hume showed that things cannot create thought, or exist otherwise or in any other sense than for thought. Therefore, thought must create things. But we find an inexhaustible material in nature which cannot be understood as the product of thought—the *matter* of perception as distinguished from the formal relations which are found to be exclusively the work of thought in knowledge; this formless matter Kant declares to become the object of knowledge—that is to attain reality—in so far as it is brought under two pure *a priori* forms, which belong exclusively to mind, space, and time. But in the constitution of the real there is something more implied, for space and time, taken by themselves, are merely the *formal possibilities* of spatial and temporal arrangement. Kant now shows that the matter of perception—the raw material of sensation of which all we can say is that it is wholly meaningless and without reality, excepting as thought makes it otherwise—is determined in the two pure forms of perception in the fundamental relations which he terms "categories," and which include not only quantity, quality, substance, cause and effect, &c., but every other relation of experience. The main difficulty in understanding Kant arises from the tendency to forget that the process of creation, which has just been in outline indicated, is not a process taking place in space and time. It is a process of pure thought which can never be made the object of knowledge, because, as has been already stated, knowledge with its distinction between subject and object implies, these very spatial, temporal, and other relations which are themselves logical elements in the process. Such thought can never be the property of an individual organism, completely dependent on what surrounds and has been before it. The finite self cannot be taken to explain the process through which, like the rest of existence, it is created. In making itself its own object thought is presented as an individual, limited like other individuals and conditions, within the field of experience. We only grasp Kant's meaning when we realise that by the thought which he finds to be creative of the objective universe, he does not mean the mind of an individual, but an intellectual activity which cannot itself become an object of knowledge, because in it and by it is created the very distinction between subject and object. Thought in this sense is pre-supposed by and is logically prior to all existence. Since it can operate in its construction of the unformed manifold of sensation into reality, only in the forms of space and time, reality is limited in its possibilities to what can be represented as existent in space and time; and from this it follows that knowledge is limited by imagination. But though our reasoning is thus only valid in so far as it is confined to actual or possible experience, thought has still, according to Kant, a power of extending itself by means of the categories alone beyond these limits, a procedure which leads to inevitable contradictions when an attempt is made to apply conclusions reached in this way to experience. It is just here that Kant's teaching becomes of interest to science, for these contradictions are the very ultimate difficulties of science, about which so much has been said of late. Kant discusses them at great length, and reference may be here made, by way of illustration, to his solution of the difficulty in the conception of the atom. In actual *experience* we cannot meet with, or in possible *experience* imagine an atom that is not of finite dimensions. Yet *reasoning* without reference to experience leads us to the inevitable conclusion, that whatever is of finite dimensions is further divisible *ad infinitum*. We predicate of the atom simultaneously that it is, and is not of finite dimensions. But in the first case we mean a conceivable object of perception in space; in the second, an unrealisable conception of thought from which no valid inference can be drawn as to reality. The two sorts of knowledge are wholly distinct, and hence their apparently contradictory results are not real contradictions. The difficulty arises not from mistaken scientific reasoning, but from the intrinsic nature of knowledge itself.

Between the representations of the relations of matter in space and time and the figments of abstract *à priori* reasoning, Kant goes on to show that there is an intermediate operation of thought, which, while it does more than create mere figments, yet does not create the real, although it modifies it. Its results are exemplified in those aspects under which the world is presented as beautiful or the reverse, and as organised. Organisation, for example—the characteristic of which may roughly be said to be that the whole determines its parts—is a species of relation which is unreal, in that it cannot be represented as a fact in space and time. For *quâ* space and time what we call and must think of as an organised whole, is merely a mechanical aggregate of parts which are external to, and independent of each other. Yet the knowledge of nature implies that the conceptions of organisation are real in the sense that experience *suggests* and forces them upon us, and without them nature would not only seem quite different from what it is, but could not be a connected whole at all. In other words, while an aggregate of purely mechanical relations is logically conceivable, such an aggregate would necessarily be quite different from the universe as known to us. The recognition of nature as beautiful and as organised is essential to its existence as nature, and these aspects cannot be got rid of although they are not real in the sense that the mechanical aspects are real. There are thus different phases in, or kinds of knowledge, all arising out of the ultimate constitution of intelligence. This result carries with it the solution for Kant of a number of difficulties. To ask, for example, how that which is organised springs out of an environment which is not organised, is to mistake a problem of knowledge for a problem of the relation of the objects of knowledge. For there is no line of demarcation which separates the organism from its environment. We speak as if there were such a line, because, for the purposes of advancing the limited knowledge of the individuals (which, because it is conditioned by space and time, cannot comprehend the whole universe *sub specie æternitatis*), it is convenient to abstract now from one sort of relations, now from another, and to talk of things as if they presented the aspects *only* of mechanism, or *only* of organisation. Kant declared that the twofold aspect was everywhere potentially present, because of the twofold operation of thought in the constitution of things.

Whether Kant was right in his conclusion that there were different *kinds* of knowledge, or whether he ought not to have taught that there were rather different stages than kinds, this is no place to inquire. When the systems of the late German philosophical writers have been stripped of what is at the same time most prominent and most useless in them, it will be found that they contain much valuable and detailed suggestion upon this point. It may be that Kant's theory of knowledge is imperfect, and that his distinctions are in many cases artificial and unwarrantable. But his criticism forms the basis of a new departure in investigation, and it cannot be understood without being to a great extent assented to. Not the least of his achievements is that he has sifted to their foundation and placed in a new light such metaphysical abstractions of science as matter, cause, organisation and mind, and has shown why and in what sense they give rise to problems which appear insoluble. His method was intrinsically the same as that of science generally, and to him belongs the credit of having brought science and philosophy into a definite connection. Those who have best followed his teaching have most clearly understood that the future of philosophy is to be looked for, not in a slavish adhesion to Kant's or any other system, but in the detailed application of his principles, to the critical investigation of the methods of particular branches of empirical inquiry. Already the effect of such an application has been shown in the new conception of history which has resulted from it, and there are indications that the time is not far away when men of science will begin to consider the position of their special departments in the light of the theory of knowledge.

It remains to be considered how far Professors Max Müller and Noiré have succeeded in making Kant intelligible to an English-speaking public. One cannot help feeling how much better the work would have been had it consisted simply of one volume containing the translation of the first edition of the "Kritik," with that of the passages from the second edition printed in the first volume. Of Prof. Noiré's Introduction it is difficult to speak with any satisfaction. It presents just such a view of the history of philosophy previous to Kant's time as used to be current in the days of Sir William Hamilton. The author's study of philosophy has apparently been the work of his leisure moments. To suppose, as both he and Prof. Müller seem to suppose, that a further development of the theory of knowledge is to be looked for from philology, is simply to ignore Kant's distinction between knowledge as a fact of experience and as that which is constitutive of experience. As has already been pointed out, it is in the former sense only that thought can be treated as dependent upon a particular organism, and consequently as related to language. In the latter sense alone, on the other hand, is it that which is the subject of Kantian investigation. Those who desire an historical introduction to German philosophy will do well to consult the pages of Prof. Caird rather than of Prof. Noiré.

As regards the translation, the comparison of what has been recently published by Dr. Hutchison Stirling with the work of Prof. Müller is not to the advantage of the latter. No doubt the work is grammatically excellent, and the style and accuracy by far superior to that of the old translations, but it lacks that grasp of the subject which enables Dr. Stirling, in translating the first part of the "Kritik," to reproduce not merely German words by English words, but German ideas by English ideas. Yet while it may be that the "Kritik der reinen Vernunft" remains yet to be translated, this is because the reproduction in the English language of such a work must fulfil ideal requirements before it can be accepted as satisfactory. Prof. Müller has given to students of philosophy much that they did not possess before, and that is far superior to the ordinary work of this sort. His offering is indeed what he intended it to be, a fitting commemoration of the centenary of the date on which was published the treatise which was destined to revolutionise philosophy. A faithful and literal translation of that treatise is a boon for which he will not find the public ungrateful to him.

R. B. HALDANE

OUR BOOK SHELF

Insects Injurious to Forest and Shade Trees. By A. S. Packard, jun., M.D. Bulletin No. 7, United States Entomological Commission, pp. 275, 8vo. (Washington: Government Printing Office, 1881.)

THE industry and energy displayed by the United States official entomologists is astonishing, and the amount of the literature of economic entomology issued by them would, if collected, form in itself a goodly library. One of these most valuable reports forms the subject of the present notice, closely printed, teeming with information, and illustrated by a multitude of excellent woodcuts. The amount of sound biological teaching is very great, and put forward in a manner that renders it intelligible alike to the "scientist" and to those for whose benefit it is more particularly intended. The author notices all the insects (mostly in great detail) feeding on particular trees, such as oak, elm, hickory, willow, pine, &c., &c., without special reference, in the first instance, to the particular *species* of these trees. This is a good plan, for it is only occasionally that certain insects are attached particularly to certain species in a *genus* of trees: these are specially indicated under the larger headings. We have often found ourselves in a dilemma in attempting a notice of these American reports, and this condition is strikingly in force with regard to this one in particular. Almost without exception, they are sound and lasting additions to the scientific literature of entomology; this one is especially so. But then there is the economic side of the question to be considered, and that is the most difficult. Naturally every insect that is attached to a particular species of plant, by feeding upon it, may in a certain sense be said to be "injurious" to that plant. Thus, in this present Report, under "Willow" we find even the "Camberwell Beauty" (*Vanessa antiopa*) included in the list of enemies; but we are quite sure that no one (not even the author) seriously imagines that it (with myriads of other species mentioned) is an "injurious insect" from an economic point of view. Certain insects feed on certain plants, and will eat no other; if the plant is exterminated, the insect disappears, and to keep up the balance of nature, it is quite possible that if the insect were exterminated in the first instance, some more destructive enemy (or disease) might eventually attack the plant. But the greater part of the enemies to *trees* commit their ravages by attacking the wood or bark, and here especially we think economic entomologists keep too much in the background the fact that many insects (and many of those here under consideration) act mainly the *rôle* of scavengers. Undoubtedly a leaf-feeder often attacks the most healthy trees, and as a rule it only becomes really injurious when present in extraordinary numbers; but with regard to what may be termed lignivorous insects, we strongly incline to refuse to see in the insect itself (in the majority of instances) the initial cause of the unhealthy condition; on the contrary we regard it as only stepping in to hasten decay commenced by causes quite unconnected with its presence. Our author, apparently unconsciously, virtually acknowledges this in his suggestions of remedies with regard to a beetle infesting the spruce (p. 277), and also elsewhere, by recommending, above all, preventive measures, these consisting in destroying all dead and dying trees, in which the insects especially abound. An unhealthy condition of the tree is the most favourable for the development of the beetle; but we are not of those who suppose a prescience in the latter which induces it to attack healthy trees for the benefit of prospectively remote generations of its descendants.

We wish Dr. Packard had not gone out of his way to coin worse than useless "*English*" *names*, many of which must prove more difficult to the class for whose benefit they are intended than are the scientific ones. With this exception, we thank him heartily for having produced a most valuable report. R. McLACHLAN

The Law of Kosmic Order: An Investigation of the Physical Aspect of Time. By Robt. Brown, jun. (London: Longmans, Green, and Co.).

A SHORT while ago we gave an account of the origin of the zodiacal signs so far as recent Assyrian researches enable us to determine it. Mr. Robert Brown has now published a little book on almost the same subject, the object of which is to trace the mythological conceptions to which the names given to the signs by the Accadians were due. He comes to the conclusion that the year was regarded by them as an extended nycthemeron, half the signs being diurnal or relating to the deities of day, and the other half being nocturnal, concerned with myths of the night. Early man thus recognised that there was one and the same law of "Kosmic Order" pervading all conceptions of time. In the course of his investigation Mr. Brown draws upon Egyptian and Iranian sources, but his chief materials are necessarily derived from the monuments of ancient Babylonia. Unfortunately the progressive nature of Assyrian study often renders what was written on the subject a few years ago more or less obsolete, and hence it happens that some of the statements on which he relies have been corrected or modified by subsequent research. Thus the name of the second zodiacal sign, as has already been mentioned in NATURE, meant "the directing Bull" in Accadian rather than "the propitious Bull," as Mr. Brown gives it. It is true that the word had both significations, but the signification of "propitious" was a later and derivative one. The name of the seventh sign again was "illustrious mound," not "illustrious altar," and seems to have referred to the story of the Tower of Babel, whose building was placed at the autumnal equinox, while the builder himself was called "the king of the illustrious mound." Such corrections, however, seldom, if ever, touch Mr. Brown's arguments or diminish the value of his interesting book. We can thoroughly recommend it to those who care to study a curious chapter in primitive astronomy.

Uganda and the Egyptian Sudan. By the Rev. C. T. Wilson, M.A., F.R.G.S., and R. W. Felkin, F.R.G.S. Two vols. (London: Sampson Low and Co., 1882.)

THIS double narrative is one of great interest. Mr. Wilson was one of the Church Missionary Society's missionaries sent out to King Mtesa on account of the favourable report of Mr. Stanley with regard to the eagerness of the Uganda potentate for instruction. Uganda, our readers will remember, is a district on the north and north-west of Victoria Nyanza, visited long ago by Speke, when Mtesa was quite a youth. Mr. Wilson's stay extended over two years, 1877-79. During that time, he had excellent opportunities of becoming acquainted with Uganda and the Victoria Nyanza and the districts on its south shores. He reached his destination by travelling west and north from Zanzibar, and was favourably received by Mtesa. He had much intercourse with that monarch, and gives a very rational estimate of his character, not by any means so enthusiastic as that of Mr. Stanley. Mr. Wilson's notes of his journey contain many additions to our knowledge of the region he traversed. The most important part of his narrative is that which relates to the country and people of Uganda. His chapters on Life in Uganda, on Uganda and the Waganda, and on the government and language of the Waganda, are full of fresh and interesting information, and will be valued both by ethnologists and geologists. Mr. Wilson is a favourable type of the missionary, thoroughly practical, a good observer, and a hard worker. He collected many specimens of plants, a list of which is given in the appendix, with vocabularies, and meteorological and hypsometrical observations. Mr. Felkin reached Uganda by proceeding from Suakin to Berber on the Nile, and up that river to Uganda—the first time that the Victoria Nyanza had been reached by that route. Both he and Mr. Wilson returned to Suakin by making a circuit round by the sources of the Bahr-el-Arab, and across by Obeid to the Nile. They accompanied the ambassadors sent by Mtesa to this country. Mr. Felkin's notes on the hydrography and natural history, as well as on the social and political condition of the country traversed, are of much interest. The work is well supplied with good maps, and has a number of good and useful illustrations. It is well worth reading.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Dr. Siemens' Solar Hypothesis

I HAVE been waiting for several weeks for answers to the following rather obvious objections to Dr. Siemens' Solar Hypothesis, but I have not seen them either asked by others or answered by Dr. Siemens.

1. How the interplanetary gases near the sun acquire a sufficient radial velocity to prevent their becoming a dense atmosphere round him?

2. Why enormous atmospheres have not long ago become attached to the planets, notably to the moon?

3. Why the earth has not long ago been deluged when a constant stream of aqueous vapour that would produce a rain of more than 30 inches per annum all over the earth must annually pass out past the earth in order to supply fuel to be dissociated by the heat that annually passes the earth?

4. Why we can see the stars although most of the solar radiations are absorbed within some reasonable distance of the sun?

GEO. FRAS. FITZGERALD

40, Trinity College, Dublin, May 16

I HAVE the pleasure to reply to the very pertinent questions put by Prof. FitzGerald as follows:—

1. The gases being for the most part hydrogen and hydrogen compounds have a low specific gravity as compared with the denser gases forming the permanent solar atmosphere. On flashing into flame in the photosphere, their specific gravity would be vastly diminished, thus giving rise to a certain rebound action which coupled with their acquired onward motion, and with the centrifugal impulse they receive by frictional contact with the lower atmosphere, constitutes them a surface stream flowing from the polar to the equatorial regions, and thence out into space. (Lest I should be misunderstood, allow me to add that I do not look upon centrifugal action as sufficing in any way to overcome solar gravitation.) Astronomers are in the habit of regarding each spheroid possessed of an atmosphere as rotating in vacuous space; under such circumstances the atmosphere must partake of the rotatory motion of the solid spheroid, and after having attained an increased depth at the equator, will assume a state of static equilibrium unless disturbed by external influences. No such statical equilibrium is possible, however, if we assume the same spheroid with its atmosphere, surrounded by an ocean of indefinite dimensions, consisting of gaseous matter not partaking of the rotation of the spheroid, although subject to its attractive influence. Equal masses will under those conditions be equally attracted both in the polar and equatorial direction, and the continued disturbance of equilibrium by rotatory motion must result in continuous outflow. Nor need this outflow be accomplished entirely at the expense of rotatory motion of the spheroid because the inflowing polar current when once established, will only have to be changed in direction by frictional action in order to convert it into the outflowing current.

2. Regarding the second question, I assume that the atmosphere of each spheroid in space is precisely such as would result from its mass, and if this view is correct, the moon also must have an atmosphere, though of so attenuated a character as to be scarcely perceptible by means of optical instruments; for as Wollaston put it in his celebrated paper, read before the Royal Society in January 1822, "it would not be greater than that of our atmosphere is, where the earth attraction is equal to that of the moon at her surface, or about 5000 miles from the earth's surface." I am well aware that in assuming atmospheric air to be a perfectly elastic fluid, the atmospheric density would at a height of only 70 kilometers not exceed the 1-7000th part of atmospheric density, and would therefore at greater distances become inappreciable; but we have evidence to show that Boyle and Mariotte's law holds good only within comparatively narrow limits, and there is other evidence referred to in my paper in favour of the supposition that such gases as are contained in meteorites are diffused through space in appreciable amounts, or the meteorites could not for millions of years have retained these gases, notwithstanding the action of diffusion into empty space.

3. The amount of vapour that would condense upon the earth under the conditions here assumed, would depend upon its mean temperature on the one hand, and on the vapour-density of the stellar atmosphere surrounding it on the other. Assuming the density of the stellar atmosphere, which, while surrounding the earth does not partake of its rotatory motion to be 1·10,000th part of atmospheric density, and saturated with aqueous vapour, the point of condensation would be according to Regnault −50° C., if the outer regions of our atmosphere should be at that temperature, and saturated with aqueous vapour, the two would be in diffusive balance; if they were at a lower temperature they would acquire, and if at a higher they would part with aqueous vapour to the surrounding medium.

4. It has long been held by astronomers that there are stars beyond our range of vision, which hypothesis would involve that of absorption of heat and light rays in stellar space; some rays are more easily absorbed than others; thus it appears to be the yellow rays which are most efficacious in the decomposition of carbonic acid and aqueous vapour in the vegetable cell. May not the same conditions prevail in space, and allow probably the rays of highest refrangibility to pass on to the greatest distance without being absorbed—I should say utilised—in doing chemical work?

C. WM. SIEMENS

12, Queen Anne's Gate, S.W., May 22

Porculia Salvania (Hodgson)

A MOST valuable and interesting addition has recently been made to the Zoological Society's collection in Regent's Park, of four—a male and three females—Pigmy Hogs (*Porculia salvania*, of Hodgson) from the Doars of Bhotan. The extreme rarity and difficulty of procuring this animal makes its presence here of the greatest interest, and these individuals will be examined eagerly, not only by naturalists, but by many Indian travellers, sportsmen, and others, who have heard of, but never had the opportunity of seeing the pigmy hog. My attention was directed to it many years ago by the late Mr. Blyth, then in Calcutta, who on my first expedition to the Nepaul Terai, in 1855, requested me to endeavour to obtain a specimen—as far as I remember, neither Blyth nor Jerdon had seen it living—Hodgson, who described and named it, had heard of its existence from the Nepalese or other denizens of the Terai, or neighbouring localities, long before he obtained a specimen. I was unable to procure one, though I made repeated attempts to do so, and enlisted many influential friends in the search, but without success; very few appeared to know even of its existence, whilst many seemed to regard it as mythical. Occasionally I met with natives who said they had heard of it, but I began to fear that it might be extinct. The four fine specimens now in the Gardens prove that such is not the case, and will furnish opportunity of supplementing Hodgson's description of the animal, which is to be found in the *Proceedings* of the Zoological Society, and in Jerdon's "Mammals of India."

These lively little pigs, weighing probably hardly as much as a hare, are most active and energetic; they resemble the ordinary pig in miniature, but probably may have some anatomical peculiarity which will interest naturalists as regards affinity with the Peccaries. The specific designation Salvania, is from the Sal (*Shorea Robusta*), as the pig is, I believe, found in that part of the Terai and along the sub-Himalayan tracts, where the Sâl tree abounds, and among the long grass in which the little creature hides itself. It is much to be hoped that they will breed, and thus enable other zoological collections to be supplied with specimens of a most rare and interesting species.

J. FAYRER

Pseudo-Glacial Phenomena

I BEG to call the attention of geologists to the following facts:—On the north-east coast of Australia, at the end of Trinity Bay, about lat. 17° S., there are steep ranges of granite abutting on the sea-margin. Every rainy season (December, January, and February) immense quantities of the granite become loosened from the upper part of the mountains, and fall in extensive landslips down the sides. These landslips or rockslips are so numerous, that in fine weather they are most conspicuous objects on the sides of the hills, and look like dry water-courses. One of these rockslips I witnessed at Cape Grafton, from a distance of three miles. The noise was terrific, and the ground trembled as though from an earthquake. On examining the blocks of granite which had slipped to the bottom of the ravine, I found many of them with their sides grooved and scratched, and one fragment was as beautifully polished on one side as if it came from the hands of a lapidary, excepting, of course, the scratches and grooves. In the course of a few centuries, much of the range will be worn away, and its sides represented by an alluvial deposit mainly consisting of angular boulders of every size and shape, many of which will be polished, scratched, and grooved. There are very few geologists who would not call it a glacial drift, even now, were not the cause so evidently before them. Will this help to explain those so-called drifts, which, like this instance, are found far within the tropics? T. E. Tenison-Woods

Union Club, Sydney, N.S.W., March 25

Variability of Number of Sepals, Petals, and Anthers in the Flowers of Myosurus minimus

In my article on "Different Modes of Self-fertilisation where Visits of Insects are wanting" (Nature, vol. x. p. 129), I gave a short account of the number of sepals, petals, and anthers in a hundred flowers of *Myosurus minimus* examined by myself. Some error must, however, have slipped into this account, the sum of the quoted flowers differing from a hundred. I have, therefore, lately repeated my examination and give here the results. In 200 flowers I now found 35 different proportions in the number of sepals, petals, and anthers. These were contained in—

Flowers	Sepals	Petals	Anthers	Flowers	Sepals	Petals	Anthers
1	4	3	4	2	5	5	3
1	4	3	6	3	5	5	4
6	5	2	3	*c* 7	5	5	5
4	5	2	4	7	5	5	6
1	5	2	5	4	5	5	7
1	5	2	6	3	5	5	8
1	5	3	2	1	6	2	5
4	5	3	3	1	6	2	6
10	5	3	4	1	6	2	7
a 33	5	3	5	1	6	2	8
23	5	3	6	1	6	2	10
24	5	3	7	1	6	3	7
9	5	3	8	1	6	5	7
1	5	3	9	1	7	2	7
6	5	4	4	1	7	3	6
7	5	4	5				
b 16	5	4	6				
14	5	4	7				
2	5	4	8				
1	5	4	9				

In general, the number of sepals, petals, and anthers increases and decreases with the size of the flower, the 12 first quoted flowers being exceedingly dwarfish ones.

It should further be considered that in combination with a certain number of sepals and petals a certain number of anthers seems to be the normal one, and from this normal (maximum) number of anthers, as to be seen under *a*, *b*, *c*, the numbers of flowers on the two opposite sides are constantly decreasing.

Lippstadt, May 16 Hermann Müller

"A Dead Heat"

Telegrams from Paris on Monday state that the "Prix du Jockey Club" had resulted in what is usually called a "dead heat." It is unnecessary for me to inform you, that there can be no such thing as a "dead heat." It is called so, I suppose, in consequence of a disagreement among the judges as to which horse first thrusts his nose beyond the winning-post. Are living judges any longer necessary to determine the results of a race? Five years ago I proposed to prove by indisputable evidence the winner of a trotting match which, in consequence of a dispute among the judges, had to be trotted over again. By means of a single thread stretched across the track, and invisible to either horses or their riders, twenty photographic cameras have been made to synchronously record positions impossible for the eye to recognise. With the aid of photography, the astronomer, the pathologist, the chemist, and the anatomist are enabled to pursue the most complex investigations with absolute confidence in the truth it reveals; why should those interested in trials of speed not avail themselves of the same resources of science? I venture to predict, in the near future that no race of any importance will be undertaken without the assistance of photography to determine the winner of what might otherwise be a so-called "dead heat."

449, Strand, W.C., May 23 Edward Muybridge

Aurora Borealis

The auroral display mentioned by your two correspondents was particularly brilliant at Oldham on the evening of the 14th inst., at 11.10. I observed at 11.15 one very fine streamer reaching quite to the Pole Star; it was of a ruddy hue, dull, and changing to purple. The horizon was cloudy, the cloud being fringed with white light, changing to rose colour. The constellation Cassiopea was at times covered with a mass of light, from whence the streamer arose, lighting up the whole of the northern sky. W. Pullinger

Oldham

Bright Meteors

1882, May 16, 11h. 0m. G.M.T. Meteor many times brighter than Venus; green, then white; began of second magnitude, 5° above main cluster of *Coma*; passed 1½° above *Iota* Urs. Maj., where it changed colour suddenly; ended, of second magnitude, 5° left of *Beta* Aurigæ. Duration 8 seconds, may have been 10. No streak. Observed from the University Observatory. A few minutes later another was seen describing very nearly the same path. G. L. Tupman

Oxford

Curious Formation of Ice

In your issue of November 24, 1881 (vol. xxv. p. 78) Mr. J. F. Duthie described small wafer-like, rather funnel-shaped pieces of ice which he noticed in October, on the slopes of the Himalayas, and asked whether such forms of ice had been observed elsewhere.

On November 30, 1881, I observed, at a height of about 7000 feet, near the hill station of Chakrata, on the outer Himalayas, ice crystals which were grouped in bundles about one inch long and one inch in diameter. The bundles consisted of prisms up to a quarter of an inch diameter, and looked at from the side the long parallel prismatic faces, and the short rectangular outlines of the ends of the prisms suggested rather the orthorhombic system of crystallisation. On looking straight at the end of the crystals, it was, however, seen that all the prisms were hexagonal, and that they ended in hollow hexagonal pyramids, thus bringing out clearly the hexagonal system of crystallisation to which ice belongs.

The hollow hexagonal pyramids showed further development in other portions of the hoar frost, and there seems very little doubt that what Mr. Duthie describes were accumulations of small crystals originally grouped in the shape of hexagonal hollow pyramids, but more or less expanded and rounded off.

I may here mention another interesting occurrence of crystals which I had the opportunity of noticing at the salt works in Cheshire. During slow evaporation of brine in a steam-heated reservoir, crystals of salt formed at the surface in the shape of hollow hexagonal pyramids. This is easily explained. Whilst the ordinary well-known hollow salt pyramids with square base form, by the gradual sinking and growth of a cubical nucleus which floats with one pair of faces horizontally placed, these exceptional hexagonal pyramides form from an original cube which floats on the water with a solid angle as its lowest point. The six lateral edges are the beginning of the hexagonal pyramids. H. Warth

Dehra Dun, N.W. Provinces, East India, April

The Existence of a Voice in Lizards

The following may perhaps be of some interest in connection with the letter of Prof. Th. Eimer (vol. xxvi. p. 29). One evening as I sat in the verandah of my house in Madras, my attention was called by a peculiar cry, and on looking up I saw that it was being made by a small lizard, apparently in a state of great terror at a snake which was uncoiling itself from the rafters close to it. I cannot say what the species of the lizard was, but it was one of those so abundant on the walls of Indian houses; it was one of two that appeared every evening, when the lamp was brought out into the verandah, and feasted on the moths attracted by the light. C. MICHIE SMITH

20, Duke Street, Edinburgh, May 5

THE ECLIPSE EXPEDITION

THE *Daily News* of Tuesday publishes the following communication from its special correspondent with the English Eclipse Expedition:—

On the Nile, between Siout and Sohag, May 6

The astronomers have now nearly reached their destination if all goes well, but it is by no means certain that everything will, for the Nile has never been known to be so low, and we have already been aground many times. To-morrow morning will see them and their instruments landed after their last water journey. The arrangements made by the Egyptian Government and by His Highness the Khedive himself, who takes the liveliest personal interest in the work, have been simply perfect. Everything seems to have been foreseen, every possible cause of delay obviated, and everything that could conduce in any way either to the comfort of the observers or the success of the observations provided. One officer of the Egyptian Government or another has been in constant attendance upon the expedition since they landed at Suez, and any indication of a desire that a certain course of action should be taken has been at once attended to. There is no shutting one's eyes to the fact, that there are many men occupying high positions in this wonderful country, through which we are now journeying, who take the keenest interest in scientific progress, and who are more than anxious, that Egypt should take her place among the more highly civilised nations, among whom science is cultivated to a greater or less extent; and there can be little doubt, that the efforts now being made to educate the people will in time bear more fruit of this soil. It is quite *apropos* to this train of thought to mention, that the fact that the admirably equipped observatory of Cairo will count for very little among the proposed observations is keenly felt. It must not, however, be imagined that because the metropolitan observatory counts for so little, Egypt possesses no astronomers. I mentioned in a former letter that it was hoped that Ismatt Effendi, a member of the Khedive's household, might be attached to the expedition. When the expedition reached Suez and the *Kaisar-i-Hind* steamed into the harbour, it was easy to see that something unusual was going on there. The Khedive had not only sent Ismatt Effendi to receive the expedition, but had sent orders to the Governor of Suez to welcome it in his name. Nor was this all. A special train had been provided for the instruments and observers, and every precaution taken for safe handling and safe custody of the former. In the morning the Governor of Suez speeded the parting guests, who were accompanied by M. Ismatt, and this gentleman soon showed how much he had profited by the long training he has received in the observatories of Paris and Washington, and it was soon acknowledged that in him the expedition not only found a most useful and agreeable companion, but a collaborator of the highest value.

On arrival at Cairo the party found General Stone, chief of the staff, accompanied by Moktah Bey, on the platform to welcome them. Of the former, it may be said that his influence for good on the higher education in Egypt and on the officers who have served under him is freely acknowledged. He has lost none of the enthusiastic love of truth for its own sake, and of science for the sake of the world, which characterises so many of the best of his countrymen; and many of his remarks touching his conception of the duty incumbent on the Government of Egypt, in aiding a work of international aim, strongly reminded me of General Sheridan's thoughts and words when he received at Washington one of the English observers of the eclipse of 1878. Moktah Bey, who has been detailed to accompany the expedition, is an officer who has greatly distinguished himself by his travels in the Soudan. He is not only an admirable administrator, but a capital linguist, while his love of work in the Soudan and in Upper Egypt in triangulation, determining latitudes and longitudes, and establishing, or endeavouring to establish, meteorological observatories, nileometers, and the like, render him also a valuable scientific ally.

General Stone, on the arrival of the instruments at Cairo, cut a Gordian knot by at once ordering the car containing them to be ferried across the Nile. There is no railway bridge over the Nile at Cairo, so that considerable time was saved and risk avoided by this measure. In fact it may be said that not only were the cases containing the instruments untouched from Suez to Siout, but that they were actually sealed up all this time. There was not much time to give to the strange sights and old memories of Cairo; even the Pyramids have remained unvisited so far, for after resting one night and spending part of the next day in official visits, the party was off again yesterday and travelled during the night down to Siout, the most southerly railway station in Egypt, and about 70 miles north of the point where the eclipse line crosses the Nile. At Siout, whither extra camels and porters had been summoned by telegraph, the sight at sunrise this morning was strange beyond all description, or at all events beyond the descriptive powers of your present correspondent. The telescopes to be used on the present occasion are of very great weight, and although they have been divided into as many separate pieces as possible, some of the cases are still very heavy, taxing the powers both of men and camels to the utmost. The camels, which were made to kneel down so soon as the cases had been got out of the railway car, groaned as they rose with such an unaccustomed weight; and giant Arabs, good-natured sons of Hercules, did the rest at the boat side. But here again a special arrangement was necessary. The Nile is so low and the steamer was already so crowded that the instruments were placed in a special boat taken in tow by the steamer. Events have shown that this precaution was by no means an improper one, for during the last hour and a half we have been firmly aground, and it does not seem as if all the shouting of the motley crew, or any manœuvring of the engine is going to get us off again. While these attempts, which seem born of confusion, are wearing themselves out, it will be as well to say a word about the final arrangements, so far as they are known to us, before we actually arrive at the station.

There are three expeditions in Egypt for observing the eclipse—a French, an English, and an Italian one. As there is so little choice of station, his Highness the Khedive has sent forward a steamer to Sohag, the point at which the eclipse track crosses the Nile, and has invited the various expeditions to use this as a *point d'appui* and floating hotel wherever their actual place of observation may be. Prof. Tacchini forms part of the Italian party, and MM. Thollon and Trépied of the French one. The latter have gone on ahead, and it is thought that their instruments are already up and adjusted, while the Italian party follows us on Monday. It is believed that the work of both of these parties will be chiefly spectroscopic. As the exposure of Capt. Abney's plates forms an important part of the English plans, it is intended to take special precaution for securing the photographic rooms and tent from dirt. With the same object in view covers have been prepared for the telescopes, which closely fit them and can be kept, it is fondly hoped, sand-tight. This brings me to say a word about the khamseen. The season this year in Egypt has been extraordinary. There has been much rain and very little khamseen, and now there is a brisk north wind blowing, which generally follows the dust wind. Hence many weather-wise people say that the khamseen is over; if so, of course, all the better. On the other hand, to-night from our sandbank we have witnessed a sunset rendered transcendentally beautiful by clouds over fully one half of the sky. It is possible therefore that if the present weather continues, the sky will not be quite so free from vapour as it is generally in Upper Egypt. To avoid the khamseen, General Stone, who has had the region reconnoitred, has suggested to the English party to occupy an eminence to the north-west of Akmin, a village a little higher up the river than Sohag.

Near Sohag, Sunday

I had got so far at 11 last night, when the time came for closing the mail bag, although we were fast aground, and apparently with less chance than ever of getting off. There were two mail bags, however, made up after all, for the service is so interfered with higher up the Nile that I am still in time on Sunday evening to send a letter which ought to catch the next Brindisi mail, though whether it does or nor is very doubtful, for we have been aground again twice to-day.

So, as we have at last arrived at our station, I will endeavour to give an idea of the proposed arrangements. In the first place, we have found the steamer on which the various parties are to live as the guests of the Khedive moored close to the shore, at a point where it trends north and south, or very nearly so, about half a mile below Sohag. This position, which has been selected by the French party—the first to arrive—is a very admirable one for two reasons. First, the constant wind during the last week has been from the north, and by keeping a staff of people watering the foreshore of the Nile, all dust is obviated. To the north of the place of observation trees, and what looks like grass from a distance, grow close to the margin of the river; so that the dust can only be of nearly local origin; while a long stretch of sandbank to the north, running east and west, is far enough away to deposit its sand in the Nile before it can reach us.

Secondly, the khamseen, if khamseen there is to be, will have to travel a mile and a half along the Nile before it can enter the observatories; and it is thought this amount of water surface will have an important effect in reducing the amount of sand in the air, even in its case also. *Nous verrons.* These considerations have induced the English party to take up ground close to the boat and their French confrères. The hills which look so tempting in the mass are simply impossible as places of observation. With the means at command here it would take a week to get the instruments up, much more in position; while at Akmim, which is only two or three miles away, there does not seem to be any spot more favourable, taking everything into consideration, than the one here.

At five o'clock to-morrow, then, the work will begin, and the next week will be a busy one, for in spite of the fresh breeze and the clouds—for there are very distinct clouds to-day—work on the sand becomes very oppressive in the middle of the day, and there are heavy weights to move, which the observers must move themselves. The scene from the ship is already interesting. To the north two tents and various shelters, to the south one tent. These will increase to six to-morrow. Here and there groups, looking down the bank, stealthily from between the trees. There is a pretty thick grove of acacia trees, which shelter us somewhat from the rays of the setting sun, still fierce in this latitude. Here and there, skirting the grove, a sentinel with fixed bayonet keeping guard. At the extreme south, tents for the military, and a long line of piled arms.

Across the water the scene is novel and beautiful in the extreme. The main Nile, in which the b at is anchored, is here about half a mile wide, but there is an island about two miles long, and a wide stretch of water beyond that. This island forms, with the river, the foreground of the landscape. With an opera-glass we can see the Fellaheen cultivating the ground almost to the water's edge in places, and looking after their crops of maize or their flocks of goats. Here comes a veiled Rachel to the sacred river to fetch water for a house in an indistinct flat-topped village, sheltered in a large group of beautiful palm trees. The arm of the river beyond the island we cannot see, but a background is not lacking. A long line of mountains, we may almost call them, full of geological tracery, are now, as I write, almost blood-red in the light of the setting sun, and are surmounted by that grey purple one always sees to such advantage in Eastern lands—both grey and purple haze in a few hours to give way to the silver dawning of the moon, now terribly dwindling in her visible surface, and reminding the astronomers of the coming seventy seconds in a most forcible manner.

The proceedings at the end of the first day on which the English and French parties found themselves together as guests of the Egyptian Government naturally included some toasts—that of his Highness the Khedive, proposed by M. Trépied, and that of the English and French nations, proposed by Moktah Bey, and responded to by Mr. Norman Lockyer. The arrangements on board are as perfect as those made at the various stations on shore, and one's national pride is a little touched at the idea of what the Government reception would be of a party of Egyptian astronomers coming to England to observe an eclipse of the sun.

ANEMOMETRICAL OBSERVATIONS ON BOARD SHIP[1]

IT is known that the determination of the velocity of the wind in the ocean has always been one of the desiderata of meteorological observations. Maury devoted much attention to this subject, and to determine, at least approximately, the velocity of trade-winds, he was compelled to work on a very unsafe basis—the velocity of ships during different parts of the year—and to put aside all observations made in accordance with the scale of Beaufort as unreliable. But it is obvious that the velocity of a ship depends on so many circumstances quite independent of the wind itself (such as the shape of the ship, the surface of its sails, the disposal of the cargo, and so on), that its velocity is but a very imperfect means of measuring the velocity of wind. Besides, the relation which exists between the force of the wind and the velocity of a ship, under different angles between the direction of both, is a new source of error, as this relation has not yet been established with accuracy, and can be established only by means of anemometric measurements. The necessity of trustworthy measurements of the velocity of wind at sea was so well understood in England that the Royal Society and the British Association established in 1859 two anemometers—one on the Bermuda Islands, and the other at Halifax. But it is known that the force of the wind is usually lessened on continents and islands.

Therefore it was absolutely necessary to make anemometrical observations on board ships, and a few attempts had already been made in this direction. Prof. Piazzi Smith invented an anemometer which might be established on board a ship, and which merited the highest eulogy from Maury, but Lieut. Domojirov does not know if any observations were made with it. Emil Bessel, during the Arctic expedition of the *Polaris*, made a series of observations with an anemometer on board his ship, but he does not explain, neither the methods of observation, nor the corrections he applied to his measurements. In

---

[1] A Domojirov, in the *Izvestia* of the Russian Geographical Society, vol. xviii. 1882, fasc. 1.

1879 Col. Rykatchoff, of the St. Petersburg Central Physical Observatory, established, on board the *Nayezdnik*. an anemometer of his own construction, which was observed during the ocean cruise of the clipper; and the schooner *Nordenskjöld*, which unhappily was lost in 1879 at Yesso Island, had also an anemometer, which was taken afterwards on board the Russian clipper *Djighit* by M. Domojirov. The observations on board of the *Djighit* were carried on with this anemometer (of Casella) put in such an apparatus (like that of the lamps on board of ships), as always maintained it in a vertical position, even during the heaviest seas, when the ship oscillated for 30° on one side, and 35° on the other. The apparatus was put on a 16-foot-long pole, which was pushed out for each observation on the wind-side of the ship, from the boat, and thus exposed to the full force of the wind for ten minutes. The height of the instrument above the sea was 26 feet. The direction of wind was determinated by means of a vane, and its true direction computed from the apparent one, on the principle of the parallelogram of forces, by taking into account the velocity of the ship. When the angle between the direction of the wind and the direction in which the ship goes is known, as well as the seeming velocity of wind (measured by the anemometer), and the velocity of the ship, the true velocity of wind is easily determined by means of simple computations, or of the tables published for that purpose by M. Rykatchoff (*Russian Marine Review*, February, 1880). A series of experiments having been made for ascertaining in how far the calculated figures agree with the true ones, M. Domojirov arrives at the conclusion that these figures are quite reliable; determination having been made during the progress of the ship, she was immediately stopped, and the determination made anew, both results always being quite identical. But the measurements from the side-boat are very tedious and even dangerous during heavy seas, and each observation occupies no less than three men for about twenty minutes. Therefore M. Domojirov proposes to apply electricity to register the rate of the anemometer.

The observations on board the *Djighit* were made five and six times per day from March 23 to May 30, and the complete results, with all elements for calculations, are published in the papers of M. Domojirov. The north-eastern trade-wind, observed on the passage from Japan to the Sandwich Islands and back, had a very regular force of from 5 to 9 metres per second; the south-eastern trade-wind experienced on the passage from the Sunda Islands to the Seyschels, had a velocity of 4 to 9 metres per second, and the south-western winds on the passage from Port Victoria to Aden, had velocities from 12 to 15 metres per second.

It would hardly be necessary to insist on the importance of such observations for meteorology, as well as for practical purposes, and we hope that soon the still prevailing prejudices as to the possibility of anemometrical observations on board ships having disappeared, and more convenient methods of observation having been devised, the anemometer will become on board ships as necessary an instrument as the log and barometer. P. K.

INSTANTANEOUS PHOTOGRAPHY OF BIRDS IN FLIGHT

PROF. E. J. MAREY has lately published in the pages of our contemporary, *La Nature*, an article on a "photographic gun," the illustrations to which, with a somewhat shortened account of the process, we are enabled, through the courtesy of the editor of *La Nature*, to present to our readers. M. Marey's researches on animal locomotion are well known; his experiments carried on by the graphic method were productive of most valuable results, and they corrected and explained many debated points in animal mechanics; but having seen some of the results obtained by Mr. Muybridge, at San Francisco, with photographic pictures taken during an exposure of the 1-500th of a second, he was very desirous to have the same process adapted, so as to admit of its being applied to the taking of birds flying. In September, 1881, on a visit of Mr. Muybridge to Paris, he brought with him some photographs of birds taken on the wing, but these unlike the invaluable series taken by the same gentleman of horses and men, were not the representation of a series of continuous attitudes, but rather represented the bird in the position it happened to be in at a moment of time; whereas, to explain the fall and rise of the wings and the positions of the body, it was, above all things, important to have a series of rapid photographs taken of the same bird over a period during which the whole mechanism was in action, so as to allow of the movements to be afterwards studied at leisure. After deliberating over this subject during the last winter, at last the idea of a photographic gun occurred to him; but the immense quickness with which the movements should succeed one another, in order to bring a series of sensitive surfaces across the lens, at first presented great difficulties in the constructing of the machine. It was necessary to have images taken successively ten or twelve times in one second, in order to

FIG. 1.—The Photographic Gun.

succeed in obtaining the various positions of the wings of a bird at each revolution. As the result of a good deal of thought and labour, an apparatus was constructed about the size of a sporting-piece (Fig. 1), which would take twelve images, in one second, of an object on which the piece was continuously sighted. The time of exposure of each image was about 1-720th of a second.

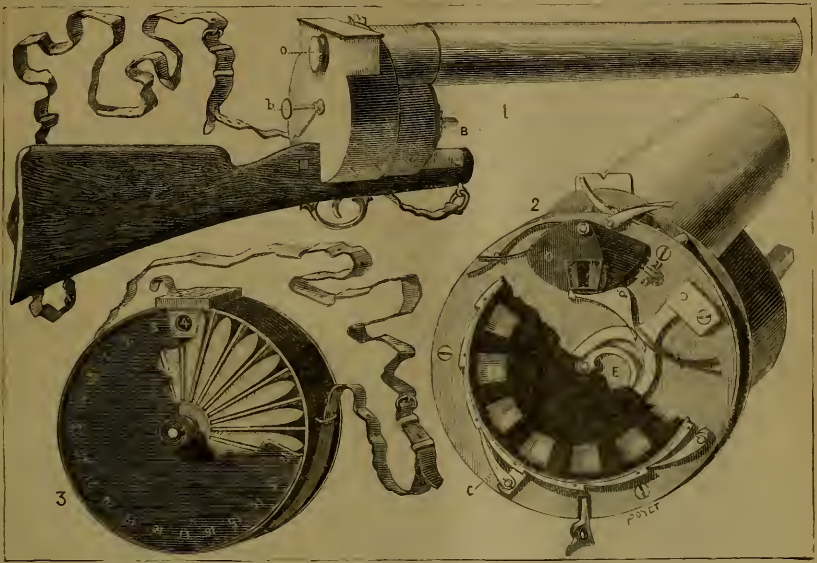


Fig. 2.—Mechanism of Gun. 1, General view; 2, Windowed disc; 3, Box with 25 sensitive plates.

The barrel of the gun is a tube containing a photographic object-glass. Behind this, and solidly mounted on the butt, is a long cylindrical breach, containing clockwork, of which the exterior of the barrel is seen at B, Fig. 2, No. 1. On pressing the trigger the clockwork is set in action, giving to the different parts of the instrument the necessary motion. A central axis, which makes twelve revolutions per second, governs all the pieces of the apparatus. Of these one is a disk of metal pierced with fine openings, which acts as a diaphragm, and only allows the image of the object to be presented twelve times in a second, and each time only for 1-720th of a second. Behind this, and revolving on the same axis, is another disk carrying twelve windows, behind which are the sensitised plates. This windowed disk revolves in such a way as to be slightly arrested in its course twelve times in a second, when the open windows are exposed to the light. The teeth to arrest its movements are seen at C, Fig. 2, No. 2, while the excentric at E, Fig. 2, No. 2, keeps up the regularity of this

Fig. 3.—Sea-gull, flying; heliograph of twelve plates obtained by the process.

Fig. 4.—Sea-gull; beginning of depression of wing.

movement. A cover over all keeps the light out from the rear of the instrument. It will be noted that during the instant of exposure, the sensitised surface is steady, and when the exposure is over, it is at once passed away. Pressure on the button (*b*, Fig. 2, 1) sets the machine in motion. Before applying this instrument to the study of the flight of birds, an experiment was made with it on a black arrow, made to rotate against a white back ground well lit up. The speed of the rotation of the arrow was about 5 metres a second. The marksman, at a distance of 10 metres sighted on the centre of the target, on which the eye could perceive nothing save a confused grey shadow, so quick was the rotation of the arrow: but on the development being completed, twelve images were to be seen, disposed in a circular manner, and each showed not only the arrow, but its shadow, as sharp as if the original had been immovable. Another experiment, equally successful, was made on a pendulum beating seconds. For to be more certain as to the duration of the exposure, M. Marey next adapted to the gun a chronographic apparatus, so that the time intervening between the taking of each picture could be with precision ascertained. After all these preliminary essays, the photography of animals in movement was attempted; and in Fig. 3 there will be seen the photographic representations of a sea-gull, in which the twelve successive attitudes assumed during the space of a single second by this bird during flight are ascertained. On other occasions other successful photographic series of a sea-gull in flight were taken when the bird was seen less in profile. The sea-gull gave exactly three strokes of its wing each second, so in the twelve photographs of each stroke four succeeding stages were reproduced. The wings at first elevated to their greatest, then commence to be lowered; then in the following image they are seen at the lowest point of their course; and in the fourth image are again on the rise. In enlarging these images, figures seen from a good distance were obtainable, but the sharpness of the enlargements left a good deal to be desired; for the negatives were somewhat granular, no doubt owing to some slight fault in the photographic process. The reproduction of these images by the heliographic process gives excellent silhouettes (as seen in Figs. 4 and 5); the originals, when examined under the microscope, showed even the wing-feathers distinctly.

FIG. 5.—Sea-gull; end of depression of wing.

On comparing the indications thus given by the photographic process with those already attained by the graphic process, a confirmation of most of the principal points obtained by the latter were obtained; but otherwise so far, the latter did not seem to add much to our knowledge of the mechanism of flying. However, ere deciding that this is so, numerous observations on different birds flying and in different conditions of flight, during calms and storms, and with and against the wind, must be taken. Attempts were also made to photograph the bat, but its small size, its flight during the dusk, and its capricious method of flying made it a difficult subject; but some of the experiments revealed interesting results. The angle of oscillation of its wings is very extended, especially from below, when the two wings form two vertical planes sensibly parallel.

These extremely interesting researches of M. Marey are only, as it were, in their infancy; he intends pursuing them much further, and his results will be looked for with great interest by all those who study the subject of animal motion.

DR. FRITZ MÜLLER ON SOME DIFFICULT CASES OF MIMICRY[1]

IN his original explanation of the cause of mimicry, Mr. Bates referred to the occurrence of many cases in which species of different genera of Heliconidæ resemble each other quite as closely as the mimicking Leptalides and Papilios resemble species of Ithomia and other Heliconoid butterflies. In these cases both the imitating and the imitated species are protected by distastefulness, and it was not therefore clear how the one could derive any benefit by resembling the other. Accordingly, Mr. Bates did not consider these to be true cases of mimicry, but to be due, either to identical parallel variations of externally similar form, or "to the similar adaptation of all to the same local, probably inorganic, conditions."

Examples of this close resemblance of species of different genera of protected groups have now become very numerous, and they often extend to three or more distinct genera, some species of which imitate each other in most parts of tropical America, each changing in a corresponding manner as we pass from one district to another.

In my Address to the Biological Section of the British Association at Glasgow, in 1876 (reprinted in "Tropical Nature"), I connected these cases with a number of others in which peculiarities of colour or of form appear together in several groups not closely allied, but always among those inhabiting the same locality and as frequently among unprotected (that is, eatable) as among protected groups of butterflies; and I concluded, generally, as Mr. Bates had done, that these curious phenomena were due to "unknown local causes."

Thus the matter rested, till, in 1879, Dr. Fritz Müller published in *Kosmos* a paper on "Ituna and Thyridia; a remarkable case of Mimicry in Butterflies"; and in 1881 a second paper, entitled "Remarkable cases of acquired resemblance among Butterflies," in which he gives a solution of the problem as really a case of mimicry. The first of these papers was translated by Mr. R. Meldola, and communicated to the Entomological Society of London in May, 1879, and the same gentleman has kindly furnished me with a translation of the second paper (the title of which is given below), which discusses the whole question in great detail, and devotes much space to a criticism of my suggested "unknown local causes" as a sufficient explanation of the phenomena. I may at once say that I admit this criticism to be sound; and that Dr. F. Müller's theory appears to me to afford a clue (with some slight modifications) to most of the cases of close individual resemblance of not-nearly-related species of butterflies yet observed. I therefore wish to state, as briefly as possible, the exact nature of the explanation now afforded us, and this is the more necessary because Dr. Müller's theory did not receive much support when brought before the Entomological Society, nor did it then satisfy Mr. Bates, the discoverer of the true meaning and importance of the phenomena of mimicry as interpreted by the doctrine of Natural Selection.

The explanation depends on the assumption, that some at least, if not all, young insectivorous birds learn by experience that the Heliconoid butterflies are distasteful, and in so doing sacrifice a certain number of individuals

---

[1] "Bemerkenswerthe Fälle erworbener Aehnlichkeit bei Schmetterlingen." Von Fritz Müller. (Separat-Abdruck aus "Kosmos," V. Jahrgang, 1881.)

of each distinct species. But if two species, both equally distasteful, closely resemble each other, then the number of individuals sacrificed is divided between them in the proportion of the square of their respective numbers; so that if one species (*a*) is twice as numerous as the other (*b*), then *b* will only lose one-fourth as many individuals as it would do if it were quite unlike *a*; and if it is only one-tenth as numerous then it will benefit in the proportion of 100 to 1. It is an undoubted fact that the species of protected butterflies, like those of other groups, differ greatly in abundance of individuals, some being very rare while others are among the commonest of all butterflies. The proportion of 100 to 1, therefore, is far below the amount of benefit an uncommon species might derive by resembling a common one. The benefit to be derived is thus clear, if the protected species are subject to the danger of attacks by young birds before they learn that such species are uneatable. I agree with Dr. Müller that they are exposed to this danger; and when we consider the great number and variety of insectivorous birds in South America the danger must be considerable, and quite sufficient to render it important for a numerically weak species to reduce it to a minimum, although to a species abounding in individuals it may be of little importance. It has been suggested that young birds have an hereditary instinct enabling them to distinguish uneatable butterflies antecedent to experience; but this seems in the highest degree improbable. It has no doubt been shown by Mr. Darwin that monkeys in captivity have a dread of snakes, and Mr. Jenner Weir believes that birds have an instinctive knowledge of uneatable caterpillars. But even admitting that in these two cases there is an instinctive hereditary aversion, it does not follow that the same will occur with regard to protected butterflies. Snakes form one well-marked group, and it is not alleged that monkeys distinguish between poisonous and harmless snakes; and caterpillars can also be readily divided into the two classes of edible and inedible by their green or brown (protective) colours on the one hand, and their gaudy or conspicuous colouration or hairy bodies on the other. But the protected butterflies have no such general mark of inedibility. Their colours and forms vary greatly, and cannot as a group be readily differentiated from those of other butterflies; and it is not to be accepted without actual proof that a young bird knows instinctively every Heliconoid or Danaoid butterfly in its district, as well as the protected Papilios and moths, almost infinitely varied as they are in colour and marking, among the equally numerous and equally varied butterflies of other groups It therefore seems clear to me that we have here a *vera causa* for the acquisition of true protective mimicry by the less abundant species of inedible butterflies.

There is however yet another cause which may have led to mimicry in these cases, and one which does not appear to have been discussed by Dr. Müller. The fact that the majority of butterflies are edible and are actually eaten by birds and other insectivorous creatures, while a considerable minority are distasteful and are thus protected, renders it pretty certain, *a priori*, that there exist many degrees of distastefulness. Certain species appear to be rejected by all insectivorous creatures, while some, though not eaten by birds, may be devoured by lizards, dragon-flies, or spiders. Some, too, may be eaten by some birds and rejected by others, and no ornithologist will think it strange or improbable that a trogon should have somewhat different tastes from a tyrant-shrike or a swallow. Again, in some species the distastefulness may extend to all the stages of egg, larva, pupa, and perfect insect, while in others it may be confined to one or more of these stages; or special dangers may exist for one species which are absent in the case of another. But it is evident, that, if these differences exist, it will be advantageous for the less protected to mimic the more completely protected species, and the fact of the affinity between the different genera, with perhaps some tendency to revert to a common style of colouration or marking, will afford facilities for the development of this class of mimicry even greater than occur in the case of the distinct and often remote families of completely unprotected butterflies. We need not, therefore, be surprised to find whole series of species of distinct genera of Heliconoid butterflies apparently mimicking each other; for such mimicry is antecedently probable on account of the greater need of protection of some of these species than others, arising either from some species being less distasteful to certain enemies, or less numerous, and therefore likely to suffer to a serious extent by the attacks of inexperienced birds. When these two conditions are combined, as they often would be, we have everything necessary for the production of mimicry.

The explanation now given, so far as it refers to the various degrees of protection, may be extended to explain those cases in which various groups of Nymphalidæ or other families appear to mimic each other; such as Catagramma, Callithea, and Agrias in one series, and Apatura with Heterochroa in another. In my "Tropical Nature" (p 257) I have remarked—"Here, again, neither genus is protected, and the similarity must be due to unknown local causes"; but this is more than we know, and I now think that some of these groups—perhaps Catagramma and Heterochroa—are partially protected, and the advantage of sharing in this partial protection has led species of altogether unprotected and much persecuted groups to gain some protection by mimicking them, whenever their general form, habits, and style of coloration offered a suitable groundwork for variation to act upon.

If these views are correct we shall have the satisfaction of knowing that all cases of mimicry are explicable by one general principle; and it seems strange to me now that I should not have seen how readily the principle is applicable to these abnormal cases. The merit of the discovery is however wholly due to Dr. Fritz Müller; and it is to be hoped that he will complete his work by obtaining, if possible, evidence of its correctness. The chief thing required is an experimental proof of various degrees of inedibility in butterflies, during the different stages of their life-history; and also some observations as to the comparative abundance of the species of protected butterflies which mimic each other. If to this can be added the proof that such groups as Catagramma, which seem to be the objects of mimicry, are partially protected by inedibility, the chief remaining difficulty in the application of the theory of natural selection to all known cases of protective imitation will have been cleared up.

ALFRED R. WALLACE

NOTES

IN reference to the Darwin Memorial, to which we referred last week, the honorary secretaries have issued a circular asking for contributions to the fund. In this memorial it is stated that though the works of Charles Darwin are his best and most enduring memorial, it is felt by his many friends and admirers that these should not be the only one. They are desirous of handing down to posterity the likeness of a man who has done so much for the advancement of natural knowledge. They wish also to establish a fund associated with his name, the proceeds of which will be devoted to the furtherance of biological science A committee has accordingly been formed, of which Mr. T. G. Bonney and Mr. P. Edward Dove are the hon. secretaries. The committee is one of the highest influence, comprising the leading foreign ministers, the two Archbishops, and the best-known names in all ranks and professions.

JOHANN CARL FRIEDRICH ZÖLLNER, whose death we recently announced, was born at Berlin on November 8, 1834.

His first publication of importance was entitled "Grundzüge einer allgemeinen Photometrie des Himmels" (1861), and in 1865 followed the work, which must be considered his principal one, "Photometrische Untersuchungen mit besonderer Rücksicht auf die physische Beschaffenheit der Himmelskörper" (Leipzig, Engelmann). The photometer constructed by Zöllner compares the light of the celestial object observed with an artificial star produced by a constant source of light (the flame of a paraffin lamp kept at a constant height), which can be varied at will by turning two of the three Nicols through which the light from the flame has to pass. A crystal plate allows of variation of colour. With this instrument Zöllner observed both the moon, the principal planets, and the fixed stars, and the last chapter of his "Untersuchungen" contains an interesting attempt to explain all the various phenomena of variable stars, sun-spots, &c., by the gradual cooling of all the celestial bodies. In several later papers in the *Proceedings* (*Berichte*) of the Saxon Society of Sciences these ideas are further developed, particularly with respect to the nature and periodicity of sun-spots. Without knowing it Zöllner here followed in the footsteps of Buffon. Zöllner next directed his attention to spectrum analysis, and on February 6, 1869, he read a paper before the Saxon Society on a method of observing the solar prominences in full sunlight; but Zöllner did not obtain a suitable instrument for carrying out his idea till some months later. His "Reversionsspektroskop" which produces two spectra side by side and in opposite directions, has been utilised by himself and others for determining the rate of rotation of the sun by the shifting of the spectral lines at the opposite limbs. Most of his spectroscopic researches relate, however, to the solar prominences. In 1871 Zöllner published a paper on the nature of comets in the Leipzig *Berichte*, and the following year he republished this paper together with two papers by Olbers and Bessel, and a number of chapters "On the Theory of Comprehension" in his well-known book, "Ueber die Natur der Cometen," which excited much comment at the time, and made him many enemies. About the same time a new chair of "Physikalische Astronomie" was founded at the Leipzig University, to which Zöllner (who had for some years been extraordinary professor) was appointed. His astrophysical activity was at that time at its height, but soon after he turned his attention to spiritualism, which seems to have absorbed all his energy of late years.

It is proposed to hold a meeting of the subscribers to the memorial to the late Prof. Rolleston on Thursday, June 1, at 3 p.m., in the Library of the Royal College of Physicians, for the purpose of determining the form that it shall take.

Mr. J. L. E. Dreyer, assistant at Dunsink Observatory, has been appointed to succeed the late Dr. T. Romney Robinson as director of the Armagh Observatory.

Prof. Haeckel has returned to Jena from his voyage to Ceylon.

There have been great rejoicings at Lucerne this week in connection with the opening of the St. Gothard Tunnel.

With reference to the communication which we published last week, from Mr. T. F. A. Brown, on the cuckoo singing at night, we have received letters from several correspondents, detailing observations similar to those of Mr. Brown. It was not a previously unknown fact that cuckoos call at night, but the fact is probably not so familiar as it might be.

M. Janssen took magnificent photographs of the recent eclipse at the Meudon Observatory, Paris, where his revolver was set into operation to determine the first and the last contact. He also took two series of photographs 90 cent. diameter, one negative, and the other positive by direct exposure, with two large refractors. This is the first time that the whole photographic power of the Meudon Observatory has been set into operation. In the sitting of May 22 of the Academy of Sciences, M. Janssen presented the photographs of the last contact obtained with his revolver during the eclipse, on Daguerreotype plates. He stated that the inspection of the several images proved the contact to have taken place at a later time than that calculated. He presented also a large image, 90 cent. in diameter, obtained with his large refractor, and stated that he was unable to detect any difference in the immediate vicinity of the moon in the representation of faculæ and the minute details of the sun's structure. He considered the fact to be opposed to the existence of a sensible lunar atmosphere, as inferred from the spectroscopic observations of the French astronomers in Egypt.

On May 17, M. de Mahy, the French Minister of Agriculture, presided at the laying of the first stone of the Observatory of Venteux, at an elevation of 1912 metres above the level of the sea. M. Naguet, deputy to the French Lower House and Professor of Chemistry, delivered an eloquent address on the opportunity of establishing mountain observatories, as inaugurated by Leverrier on the top of Puy-de-Dôme (1465 metres), and practised at the Pic du-Midi (2877).

A local observatory has been established at Besançon, in order to determine the exact time by astronomical observations. This city is considered as the headquarters of French watch and clock making.

Mr. C. L. Wragge, F.M.S., has just established a meteorological and climatological station at the Sanitary Depôt, Stafford. Mr. J. B. M'Callum, the borough surveyor, and his brother, Mr. T. M'Callum, have kindly undertaken to observe for Mr. Wragge every morning at nine o'clock (local time). The instruments are all standards, verified at Kew The elements of observation consist of air and earth temperature, moisture, rainfall, direction and force of wind, kind and amount of cloud, hydrometers, and probably ozone.

Griesbach of Gera (Reuss, Germany) announces the issue of Frisch's edition of Kepler's Works (eight vols.) at about one-half the original price.

The June number of the *American Naturalist* will contain a biographical notice of the late Mr. Darwin by Dr. Packard, and the articles will be devoted almost exclusively to the subject of Evolution.

M. W. de Fonvielle writes to us as follows:—"I am in a position to send a few interesting particulars of an aëronautical ascent which was made on May 18 by M. Eloy, in compliance with the programme alluded to in last week's Nature. The ascent was made on the 11th day of a well-defined period during which the prevailing wind was almost without intermission a strong north-easterly breeze which has been detrimental to agriculture. The sky was clear deep blue, and the air cold and dry. A large number of dense small cumuli, dark, well defined, with round edges, were seen carried by with the wind almost without intermission, except during the eclipse, when the weather was magnificent. This period having terminated only on the 20th by a total change of wind, the observations taken may be considered as giving a fair idea of the atmospheric conditions which prevailed during so many days. These clouds were floating at an altitude of more than 2000 metres, and very cold, the thermometer having descended abruptly to −4° and −6° centigrades. When crossing this cloud, the aërial travellers perceived no isolated flakes of snow, but the air seemed illuminated by sudden lights, as if rays travelling from the sun had been reflected by minute icy particles. The balloon having ascended to the upper surface of the clouds, and travelled during more than an hour out of view of the land, the aëronauts were unable to perceive the aureole round the shade of the balloon, which remained visible during the whole of the excursion on the upper face of the clouds. I explain this circumstance by the fact that the cloud was formed by solid water and that the aureole was less easily detected than when it is formed of vapour, being less brilliant, the same relation between these two phenomena existing for luminosity as between halos and rainbows. The aeronauts having remained at an altitude of two to three hundred metres from the clouds, were unable to perceive the coloured rings which were visible to me and M. Brissonet, navigating only at a few metres above similar legions of icy particles. It may have also occurred that our friends were blinded by the light from the sun, which at four o'clock was very powerful, and so detrimental to their eyes, that before entering the clouds they were unable to look fixedly at the earth to ascertain their path. It is the first time that I have heard of aeronauts having experienced the want of coloured spectacles to inspect our planet.

THE new Eddystone Lighthouse, which replaces Smeaton's famous work, built 120 years ago, was opened by the Duke of Edinburgh last Thursday.

UNDER date of Constantinople, May 17, an earthquake is reported to have occurred in the island of Karpathos.

THE first number of a small publication bearing the title of *Studies in Microscopical Science*, and edited by the well-known preparer of microscopic objects, Mr. Arthur C. Cole, F.R.M.S., "assisted by several eminent specialists," has just been published. It consists of a description and lithographed figure of a microscopical slide, which is issued, along with the description, to subscribers. The subject of this first number is yellow fibro-cartilage, and the preparation on the slide is a longitudinal vertical section of the pinna of the cow's ear. It is double stained in logwood and eosin, and is a well-mounted and highly-finished object. The plate is fairly good, though perhaps a little wanting in softness; it represents the section under a magnifying power of 333 diameters. The eight pages of descriptive letterpress contain—1. The name of the object and its etymology. 2. A very good description of the preparation under different powers, and of yellow fibro-cartilage in general, after the action of various reagents; also a few remarks upon its physiology. 3. An account of the different methods of preparation which may be employed, with their respective advantages and drawbacks; and lastly what seems a very complete bibliography of the subject. Altogether this first number has been well carried out, and promises well for the rest of the series. There is no doubt that *if the subjects are judiciously chosen*, this periodical will be a success, as it ought to be of great use to students and amateur workers in science. It is a pity that no list of the proposed subjects is given. It would be a decided advantage to know what the series for the present year will probably be, but beyond the fact that twenty-six histological will alternate with eighteen botanical, and eight petrological preparations, one issued each week, the prospectus tells us nothing.

A CURIOUS fact regarding a dragon-fly (*Æschna cyanea*, Müll.), often met with near Florence, has been observed by Signor Stefanelli. There were several nymphs of the animal in a cistern of water. Some which were near being transformed came out of the water a little way during the night, and, attacking several of the new-born perfect insects which had not yet begun to fly, voraciously devoured them. This singular practice (it is suggested) may explain why one finds such a small number of *Æschna cyanea*, in comparison with the number of nymphs. In raising the larvæ and nymphs of the dragon-flies, the best food, according to Signor Stefanelli, is meat, and especially fish.

THE Queenwood College Mutual Improvement Society seems to be an unusually active one. We have received a very favourable Report for the past term; the work done is very varied, and several of the lectures and papers have been published separately in a neat form.

FROM the Report of the Cardiff Naturalists' Society for the past year we learn that it is in a highly satisfactory condition.

A NEW work, entitled "The Hall Marking of Jewellery Practically Considered," by George E. Gee, author of "The Goldsmith's Handbook," "The Silversmith's Handbook," &c., is announced for immediate publication by Messrs. Crosby Lockwood and Co., London. The work will include an account of the Assay Towns of the United Kingdom, the Stamps at present employed, and will deal fully with the Laws relating to the Standards and the Marks at all the existing Assay Offices, &c. The same publishers also announce a new and enlarged edition of "The Manual of Colours and Dye Wares: their Properties, Applications, Valuation, Impurities, and Sophistications," revised and enlarged by the author, Mr. J. W. Slater.

A REVISED edition of the rules for the International Fisheries Exhibition to be held at South Kensington next year, has been issued. Among the prize essays are the following:—(1) 100*l*. The Natural History of Commercial Sea Fishes of Great Britain and Ireland, with special reference to such parts of their natural history as bear upon their production and commercial use. This would include natural history, habits and localities, fish frequent at different seasons, and artificial propagation. (This will not include the Salmonidæ.) (2) 100*l*. The effect of the existing National and International Laws for the Regulation and Protection of Deep Sea Fisheries, with suggestions for improvements in said laws. (3) 100*l*. On improved facilities for the capture, economic transmission and distribution of sea-fishes. Second-Class Prizes (amount not determined):—(1) On the introduction and acclimatisation of foreign fish. (2) On the propagation of freshwater fish, including Salmonidæ. (3) On oyster culture. (4) On the best means of increasing the supply of mussels and other molluscs (oysters excepted) used either for bait or food.

IN a recent paper called "Le Grain du Glacier" (*Arch. des Sciences*, April 15), Prof. Forel ably investigates the phenomena of glaciers, developing a theory similar to Hugi's and Grad's, and which he would rather designate by *increase of the crystalline grain*, than by *dilatation*. The crystalline grain is found to increase as the glacier descends: from the size of a small nut at the limit of the *névé*, it becomes as big as a hen's egg at the terminal part; Prof. Forel has seen grains at the lower end of the Aletsch and other glaciers, 7 or 8 ctm. (over 3 in.) in the longer diameter. He estimates the volume-increase at about 4½ per cent. annually. Molecular affinity is the force which augments the crystal at the expense of the water which has penetrated the mass, circulating in capillary fissures. For details of the theory, and meeting of objections, we must refer to the original. *Inter alia*, Prof. Forel finds evidence against the view (which is adverse to the dilatation theory), that the central temperature of a glacier remains at zero, invariably and constantly. He considers the mean temperature of a glacier at the end of winter to be somewhat less than seven degrees below zero C.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. F. Foreman; a Collared Peccary (*Dicotyles tajaçu*) from South America, presented by Mr. G. H. Hawtayne, C.M.Z.S., a Mediterranean Seal (*Monachus albiventer*) from the Mediterranean, presented by Mr. M. Yeats Brown; an Oak Dormouse (*Myoxus dryas*) from Russia, presented by Prof. Wrzesniowsky; two Argus Pheasants (*Argus giganteus* ♂ ♂) from Malacca, presented by Major McNair, C.M.G., and Mr. J. M. Vermont; two Common Buzzards (*Buteo vulgaris*) from Scotland, presented by Mr. J. Faed; a Great American Heron (*Ardea herodias*), captured at sea off Cuba, purchased; a Ruddy-headed Goose (*Bernicla rubidiceps*), bred in the Gardens. The following species of Butterflies and Moths have been exhibited in the Insect House during the past week:—Silkmoths: *Samia cecropia*, *Attacus cynthia*, *Attacus pernyi*, *Attacus atlas*, *Attacus roylei*, *Actias selene*, *Actias luna*, *Cricula trifenestrata*; Butterflies: *Papilio machaon*, *Anthocharis cardamines*, *Thais polyxena*, *Melitæa cinxia*; Moths: *Smerinthus ocellatus*, *Chærocampa elpenor*, *Proserpinus œnotheræ*, *Sesia scoliæformis*, *Sesia spheciformis*, *Trochilium apiforme*, *Sciapteron tabaniforme*, *Pygæra bucephala*. Twelve specimens of a leaf insect (*Phyllium scythe*) from eggs transmitted by Mrs. M. A. Meres and Mr. Wood Mason from India, have also emerged.

OUR ASTRONOMICAL COLUMN

THE TRAPEZIUM OF ORION.—Prof. Holden, in an appendix to the Washington observations for 1877, has discussed a long series of measures of the multiple-star Σ 748, made with the 26-inch refractor by Prof. Asaph Hall in 1877 and 1878. It is now known that the nebula in Orion was discovered by Cysat in 1618, thirty-eight years before Huyghens published an account of it, and his discovery is mentioned in his "Mathemcta Astronomica de Cometi Anni, 1618"; Bessel refers to it in his investigation of the elements of the great comet of this year, in the *Berliner Jahrbuch* for 1808. Cysat does not distinctly mention the number of stars, but clearly indicates their locality. Huyghens, in the "Systema Saturnium," 1659, describes his own discovery of the nebula, and refers to "three stars close together," which are shown in an accompanying figure. He saw the fourth star, completing what is now known as the trapezium of Orion on January 8, 1684, and Prof. Holden records that the last observation made by Huyghens was upon this system, on February 4, 1694, and the sketch in his manuscript journal under that date gives the four stars. In Hooke's "Micrographia," published in 1665, is a note (to which the attention of the American astronomer was drawn by Mr. H. B. Wheatley), which would imply that he was aware of the existence of the fourth star (notified by Cassini in his treatise on the comet of 1652), and of the fifth star, the discovery of which is usually attributed to W. Struve. He writes: "In that notable asterism also of the sword of Orion where the ingenious Monsieur Hugens van Zulichem has discovered only three little stars in a cluster, I have, with a 36-foot glass, without any aperture [diaphram] (the breadth of the glass being some three inches and a half), discovered five, and the twinkling of divers others up and down in divers parts of that small milky cloud." Sir John Herschel, in the *Memoirs* of the Royal Astronomical Society, vol. iii. mentions that Sir James South had pointed out to him in the original M.S. journals of the Royal Society a note which runs thus: "September 7, 1664 Mr. Hooke . . . the same relateth to have found those stars in Orion's belt, which M. de Zulichem maketh but three to be five." Prof. Holden made some special experiments in January, 1878, with the 26-inch refractor at Washington, the aperture reduced to 3½ inches, and arrived at the conclusion that if the fifth star were of the same brightness in 1664 as at this time, it would not have been discovered by Hooke; but, on the contrary, Mr. Burnham has brought together a number of cases in which the fifth star has been seen recently with such an aperture. The sixth star was detected by Sir John Herschel in 1830. Of other stars, suspected by several observers, Prof. Holden, during six years' observations of the nebula surrounding the trapezium, has not discovered any trace.

The Washington measures in 1877 were made in a dark field with the wires illuminated by a red-glass lamp; those of 1878 were made with the field illuminated, and with black wires. The mean results of the two years' observations of the four principal stars, after a complete reduction, are as follow, for the epoch 1878·0:—

	Position.	Distance.		Position.	Distance.
	° ′	″		° ′	″
ab ..	311 7·2 ...	13·118	*bc* ..	95 37·1 ...	21·758
ac ...	61 9·8 ...	13·454	*bd* ...	32 57·7 ...	8·774
ad ...	342 18·4 ...	16·773	*cd* ...	299 21·0 ...	19·364

The results obtained by South in 1820, W. Struve in 1836, Liaponoff in 1849, O. Struve in 1870, Nobile in 1876, and Jedrzjewicz for 1878, are brought together for comparison in Prof. Holden's paper.

Measures of the fifth and sixth stars in 1877-78, give the positions and distances subjoined, for 1878-0:—

	° ′	″
a and *a*′ ...	121 25·2 ...	3·984
a and *b*′ ...	320 43·3 ...	16·504
b and *b*′ .	352 8·0 ...	4·194

In conclusion, Prof. Holden remarks: "It appears that after making due allowance for the unavoidable, accidental, and systematic errors, the comparison of all our measures on the six stars of this system shows their probable physical association."

THE COMET.—During the last fortnight the increase in the brightness of the present comet appears not to have differed sensibly from that indicated by theory. On May 21 it was hardly below 5·5m.

GEOGRAPHICAL NOTES

AT the Anniversary Meeting of the Royal Geographical Society on Monday, the medals were presented, as we said some time ago they would be, to Dr. Nachtigal and Sir John Kirk. Mr. Francis Galton gave some account of the progress of geographical teaching in schools, which the Society endeavours to promote by holding examinations and the grant of medals, &c. He quoted a passage from the report of the examiner, Prof. H. N. Moseley:—"I have," Prof. Moseley says, "to congratulate the society on the good work effected by its annual award of school medals. As my experience as an examiner in geography increases, the more I am convinced of its pre-eminent fitness as a subject of education, and the more I deplore that it is almost entirely neglected as such in this country. Competent teachers of the subject appear to be scarce indeed, but it is amply apparent from the society's examinations that most valuable results can be produced by really able instructors." This was the fourteenth year in which these examinations had been held, and fifty-six medals—four annually—had been awarded, while altogether ninety-eight boys had obtained honourable mention. Of fifty-two schools invited to compete, forty-one had sent no candidates. Among these the Liverpool School had been distinguished, its scholars having gained medals fifteen times; while Dulwich had obtained eleven medals since 1875, and two in each of the last three years. In the Scotch and Irish schools the boys were younger than in the high schools of this country, and that accounted, perhaps, for the fact that of five Scotch and seven Irish schools invited to compete, only two in each country had accepted the invitation. He regretted that the great schools of Rugby, Shrewsbury, King's College School, and St. Paul's School, London, had not yet sent competitors. The president then reviewed the progress of geography during the past year. He referred to various efforts which were being made to train those who might have opportunities of pursuing geographical research. Sir Allen Young, the president stated, was busy getting ready the whaler *Hope*, which he has hired, for the search for Mr. Leigh Smith and his party.

WE referred some weeks ago to the unusually early date at which ice appeared in the Atlantic this year; the supply has gone on unceasingly since, and the New York correspondent of the *Standard* states that the reports made by ships coming westward read like accounts of Arctic explorations:—One ship passed icebergs almost daily between May 7 and 17, in latitude 43 deg., longitude 37 deg. Many were of immense size, and were visible for forty miles, others were within arm's length of the ship's side. Arctic animals were seen upon them, some living, and others skeletons. The Atlas liner *Ailsa*, from Aspinwall, reports that in the middle of the afternoon of the 7th it was dark, and lights were necessary. Ten waterspouts were observed whirling in dangerous proximity to the ship. They were rendered visible by the lightning. The captain of her Majesty's ship *Tenedos* reports that the ice is nearly solid from Cape Breton to Newfoundland, and that two ocean steamers have been caught in it. The brigantine *Rescue* was completely crushed near Belle Isle. The crew, numbering seventy two, took to the ice, although there was a heavy rolling swell surging among the floes. A perilous passage was made by the steamship *Mastiff*, of Scotland, which has arrived at Montreal She was among the ice for nine days. The crew and passengers, becoming desperate, cut a passage through the ice, which was sometimes twenty feet above the water. Another ship, the *Western Belle*, from Greenock, struck an iceberg off Newfoundland on May 1, and sank instantly with her captain (Frew) and thirteen hands.

HEFT V. of Petermann's *Mittheilungen* contains a long account, by Dr. Wocikof, of his journey in Mexico and Central

America; a paper of much interest by Dr. Konrad Jarz on the ice caves of Frain in Moravia; a short account, from the Russian of Fetisoff, of the Jashil Kul or Kulduk Lake in Central Asia (40° 45′ N., 76° 42′ E.); and some account of the Fiji Islands, to accompany an excellent new map of the group.

BARON NORDENSKJÖLD has published the first volume of the "Scientific Results of the *Vega* Expedition." It covers 800 pages with maps and tables. Besides the papers on the Aurora, of which we have already given an account, there are papers on the Health of the Expedition, the Colour Sense of the Chukchis, on the Botanical Collections, Meteorological Observations, the Invertebrata of the Arctic Seas, and other matters, by the various members of the expedition.

MESSRS. MACMILLAN AND CO. have published a sixpenny edition of Waterton's famous "Wanderings in South America," with the biographical introduction and explanatory index of the Rev. J. G. Wood, and 100 illustrations.

CAPT. BURTON and Commander Cameron have returned to England from their visit to the West Coast of Africa.

THE Geological Society of Stockholm will send a party to Spitzbergen this summer for the geological survey of that island. The two members selected for this object are the well-known geologists, Dr. Nathorst and Baron de Geer, who will leave Drontheim on June 1 in the whaling smack *Bjona* for their destination.

FOOD-PLANT IMPROVEMENT [1]

THE food question may be divided into two parts. 1. Its production (raw material). 2. Its preparation when produced. It is my intention to consider the first part only—food production. This, again, seems naturally to divide itself into: 1. Plant-food. 2. Animal food. And again, I propose to speak mainly of the first alone, alluding only incidentally to animal-food, upon which I will commence by making what remarks I have to make in order to clear the ground for the consideration of *plant*-food, the subject upon which I have been invited to address you. The improvement effected in the production of animal-food by the careful breeding or long repeated selection of sheep, cattle, and swine is so well known as to render it quite unnecessary to occupy much of our time in its consideration; I will only adduce one or two striking illustrations to show the *kind* of change which has been thereby accomplished. There is very strong ground for believing that the celebrated improved breed of shorthorn cattle is descended from a race originally black. Now black seems to have been in the eyes of all the best breeders of it a colour to be got rid of or wiped out, and this most certainly has been effected, for no single instance of it is now to be found. The improvement in the outward form of the animals has been carried almost to the breeders' ideal of perfection. These are external changes. Early in the history of shorthorns the breeders in Yorkshire made the production of milk their chief point, while those in Durham saved for breeding purposes the progeny of those cows only which showed the greatest tendency to lay on meat, and the result is the "Improved Durham," the pride and glory of the modern cattle show, but which are very poor milkers; while the "York" shorthorn is synonymous with a cow specially productive of milk. These are internal changes effected in *animals* by selection. When we turn to plants what do we find? The first thing, and which is apparent to everyone, is that each produces "fruit after its kind." But close observation shows something more than this, viz. that, although each produces "after its kind," no two plants of any kind are absolutely alike. I speak not of monstrosities, of which the characteristics are not heritable, but of that ever present tendency throughout nature to variation, of which the horticulturist has availed himself. These variations, of which we can profit through the great principle of inheritance are generally slight, so much so, indeed, as to be quite inappreciable by the untrained eye or hand, but they are, nevertheless, striking enough to one competent to observe them. I will give a familiar illustration of this. Nothing can well seem more alike to an ordinary person than the sheep composing a well-bred flock, but the shepherd knows them all apart as well as if each had a name. To him they are no more "all just alike" than are the members of his own family. That these differences, apparently so slight, can be practically availed of, the existing improved breeds of sheep prove beyond doubt. I have already said that no two plants are absolutely alike. Of any two, then, one must be (in the direction of the difference between them) superior to the other. This fact, coupled with the principle of inheritance, is the very key-note of all possible plant-improvement. But, it may be asked, do plants offer opportunity of improvement by breeding equal to that presented by animals? Surely much greater. A cow or ewe produces at a birth one (or two) only—a single grain of wheat has produced a plant, the ears upon which contained 8000 grains all capable of reproduction. Now we can plant all these, and of the resultant 8000 plants reserve only the best one of all to perpetuate the race, rejecting every other. Can anything approaching such a choice as this be afforded any breeder of cattle or sheep, no matter how extensive his herd or flock? The advantage on the side of the wheat becomes almost infinite when it is considered that in the case of the above animals three years (instead of one) are required for each reproduction.

Before giving a few examples of results already obtained in cereal development, I will mention analogous improvements obtained in vines and in beetroot cultivated for sugar. Many years ago an old friend from Piedmont, having a relative a vine grower in Italy, carried back with him from here a sufficient knowledge of my system of selection to enable him to explain its principle. Some seven years after, upon my friend again visiting me, he told me that his relative, knowing him to be in London, had written to ask him if he could arrange there for the disposal of his wine, and that he, without reading this letter through, at once replied in the affirmative. This he did, as he knew the small extent of his relative's vineyard—some 12 acres. "You may judge of my astonishment," said this gentleman to me, "when upon reading his letter to the end, I found that he had, without having increased the extent of his vineyard, three times the quantity of wine he formerly produced, and this simply through having followed the plan of selection I had suggested to him." The cultivation of beetroot for sugar is a very important one, and any increase in the percentage of sugar contained in it is of very high value. The following from Toronto, Canada, appeared in the *Gardener's Chronicle and Agricultural Gazette* of March 22, 1873, under the head of "Foreign Correspondence":—"The most vital point, however, of the beetroot grower is the quality of the seed he uses; when beets were first grown for sugar, 5 per cent. of sugar was the amount obtained, now 15 per cent. is obtainable in favourable instances. This has been attained entirely by the improvement of the pedigree principle of the seed. The quality of richness in the root was attained by Vilmorin in the following manner:—Each root is a perfect plant, and therefore, in the examination of each root for the production of seed, the quality of it had to be ascertained. For this purpose, Vilmorin had a set of most delicate instruments made for the determination of specific gravity, and he found that the specific gravity was indicative of the sugar contained. The cups he used were no larger than a lady's thimble, and the saccharometer or measure of specific gravity equally small. The roots were first selected according to the best ordinary rules, then a small portion of each root was punched out of it in such a part as to injure as little as possible its future growth; the pieces were reduced to pulp, and the juice was extracted. All the roots which did not yield juice up to a certain standard were rejected, whilst those which reached the standard were planted for seed; the roots produced from this seed *were found to be constantly increasing in richness*, and a few years of the process produced the great percentage of sugar which is now attained." I may here mention in reference to the foregoing that I had, so long ago as 1860, come to the conclusion that vigour of vegetable growth was identical with the power of supporting animal life, and that specific gravity was the measure of both. The difficulty of determining the specific gravity of a grain of wheat without impairing its vital vigour was, however, found insurmountable.

I will now refer to results obtained in cereals by selection, taking wheat as the illustration. The chief points to attain are vigour of growth, hardiness, productiveness, and quality, and these have become as permanent characteristics of the pedigree cereals as are the good points of a thoroughbred animal, and reproduce themselves as surely. I begin with a report from near Perth, Western Australia, in 1862, nineteen years ago. "The English wheat (Hallett's) sown before I came, produced when drilled 29 bushels per acre; and when dibbled, 35 bushels per acre. The average crops about here are under ten; ours were six; and our neighbours' opposite 4½ bushels per acre. The

---

[1] Paper read by Major Hallett at the Brighton Health Congress.

largest ear produced 113 grains. The greatest number of ears on one 'stool' was 72." And next I give the *last* report received *of the same wheat*, from New Zealand, published in the Otago *Daily Times* of June 3, 1881:—"We have been shown two samples of wheat grown by Mr. M. C. Orbell, at Waikouaitai, and we do not remember to have seen any to compare with them in this country. They are known as Hallett's Pedigree wheat, Hunter's White, and Original Red. The yield exceeded anything ever grown in the district before. Mr. Orbell sowed 1¼ bushels upon one acre, and the yield was 72 bushels (or nine quarters) of good marketable wheat. Many of the plants consisted of over 90 ears, some of which contained as many as 132 grains each. Hallett's Pedigree white Canadian oats, introduced by the same importers, have, we understand, been cultivated by Mr. Shannan, of Conical Hills Station, with the same success as the wheat grown by Mr. Orbell." Thus, after 18 years (not without further selection, but the selection, having been continued annually at Brighton throughout the interval), the *same wheat* is found not only to have maintained, but to have further developed its vigour of growth, producing over "90" ears (instead of 72 ears) upon a plant, with 132 grains (instead of 113) in an ear. In England, 1876, 105 ears on a plant contained more than 8000 grains. (The average number of grains in an ordinary ear is 22 only.) From Essex in the same year as the date of the report first given, a crop of the *same wheat* was reported of 27 quarters on three acres, or nine quarters per acre, exactly the same quantity as that just given as obtained eighteen years later in New Zealand! Can illustration further go that there is no deterioration if only the selection be continued? Here is another experience in another year and country:—M. Tréhonnais, editor of *La Revue Agricole de l'Angleterre*, writes October 9, 1865, from Brussiéres, France—"I am now staying here, a large farm where your wheat is extensively cultivated. The average this last harvest was at the rate of seven quarters to the English acre; the average of the other sorts in the same district did not exceed three quarters per acre."

Thus far as to vigour of growth and productiveness. I will now give examples of the other two points named, hardiness and quality. Report of the Minister of the Interior, Belgium: "I continue to sow the varieties of wheat improved by Hallett, above all the 'Red,' and 'Victoria' white. These varieties are very hardy. During the winter 1875 and 1876 many of our varieties of wheat have been destroyed by frost. The Hallett Red has successfully withstood the frost. It has been the same with the Victoria. On the other hand, the variety 'Galand' has been completely destroyed, not a single plant of it left. We have seen many fields of even our 'little red' variety, very hardy, which have greatly suffered." Lastly, as an example of sustained quality, a report from Linlithgow, Scotland, dated November 23, 1878: "I have again, making now ten years in succession, had the honour of topping the Edinburgh market with your Hunter's white wheat. I sent some of your barley to Australia, and in a few years it spread and gave immense satisfaction." The pedigree cereals having been grown in upwards of forty different countries in Europe, Asia, Africa, America, and Australasia, it is, of course, impossible to give, in such a paper as this, any idea of how widely *extended* has been the success of selection as exemplified in them, but I may mention that, in acknowledgement of that success, the Minister of Agriculture at St. Petersburg placed at my disposal the collection of all the agricultural colleges of Russia; and the Minister for Hungary sent through the Austrian Embassy at Vienna, and published, a most flattering communication showing results obtained by his Government by adopting my system. From Italy, Holland, Denmark, and Sweden, I have received similar acknowledgments. The Government of the United States published my system *in extenso* in the report for 1874 of the Department of Agriculture. The English Government, too, as will presently be seen, did me the honour to appropriate and apply my system in India.

A very practical acknowledgement has been made by less distinguished persons at home. When I commenced my system, now nearly twenty-five years ago, nothing had been done or attempted in the matter of the systematic improvement of food plants. One searches the advertising columns of the newspapers of that day without finding any of those announcements with which they now positively bristle, of seeds of all kinds, "of repeated selection," of "the latest selection," &c. But now many persons and firms, supposed to be of the highest respectability, and among them, as is always the case, some who ridiculed my work at the outset unblushingly try to identify their productions with my own, a sure and certain evidence that the reputation resulting from my system of selection has a very practical value.

In the case of the potato, next to the cereals in importance as a food plant, I have also applied my system, starting every year with a single tuber, the best of the year (proved to have been so by its having been found to produce the best plant), for now fourteen years. My main object here has been absolute freedom from disease, and these potatoes are now descended from a line of single tubers, each the best plant of the year, and absolutely healthy; and concurrently with the endeavour to wipe out all hereditary tendency to disease, I have always kept in full view the point of increasing productiveness. The result may be thus shortly stated. Dividing the first twelve years into three periods, the average number of tubers upon the annual best plant selected was, for the first period of four years, 16; for the second period of four years, 19; for the last period of four years, 27, or nearly double the number produced during the first series of four years. And if, as I might very fairly have done, I had confined the first period to the first three years (instead of four), the last period would have shown an average of 27 tubers against 13 in the first period, or more than double. Here, exactly as with the number of grains in the ear of the cereals, we reach in the last period of a long series of years a standard altogether higher than in the first years of the series, *and this no matter how we divide it into "periods."* In the latter "periods" of a series of years the results vary according to season and circumstances; but (except in a case of disaster) in no year of the last year of a series *do they drop back to the standard of the earliest years!* Can it possibly be conceived that all this is mere chance or accident? Is it not the fair conclusion, rather, that nature offers to us—nay, tempts us with—on every side rewards for intelligent observation, if we will only learn the lessons and avail ourselves of the variations which she presents to us?

I have hitherto spoken of food plants only, of vines, beetroot, cereals, and potatoes, but in a Health Congress such as this, I may be permitted also to refer to plants destined for clothing; of little, if of any, less importance than food to the health of mankind. I will take the cotton plant as an illustration. In the *Times of India*, November 6, 1869, an article headed "Cotton Report" says: "The Cotton Administration Report for the past year concluded with an interesting notice of the experiments made last season and of others which are now in progress in different parts of the Presidency, for growing cotton of an improved quality. To those who remember the conclusions recorded by Mr. Walter Cassels, in 1862, in his work prepared and printed on account of Government, it may seem strange that such experiments are now undertaken at all. These conclusions, drawn from the past history of cotton cultivation in Bombay, were (1) that 'exotic cotton cannot be successfully cultivated on a large scale in Bombay Presidency, except in a limited portion of its southern districts'; (2) that 'Indian cotton may be improved in cleanliness and somewhat reduced in cost, but the general characteristics of the staple will not be materially altered.' Because lacs of rupees had been in a long course of years expended in cotton experiments, and these had resulted in a long list of failures, it seems to have been supposed that the utmost had been tried in vain, and that the question had been finally set at rest." The article, having referred to Mr. Cassel's opinion that the failure of exotic cotton when cultivated on a large scale was due to the violence of the Indian season, continues thus:—"The climate of Hindostan is, we admit, in nearly all that relates to cotton, very different to that of any but the most arid districts in our Northern Deccan collectorates. But it is plainly a fallacy to attribute to climatic influence results for which other causes can be found independent of the climate, and, unlike the climate, quite within our control. One of these causes is indicated in a Minute by the Governor of Bombay, dated January 10, 1869, in which his Excellency, who attaches great importance to the subject as one 'of vital interest to this Presidency,' remarks that 'the experiments that have hitherto been made by the order of Government with a view to improvements in the cultivation of cotton, do not appear to have been hitherto carried out with sufficient persistence or sufficient method. So that, in fact, as remarked in the report before us in the matter of Indian cotton improvement, we are yet but on the threshhold of our experience, but let us hope that the course will now be distinctly mapped, and that we may be saved from the task of beginning our experience again and again. What is still wanted, not only in the North-West Provinces and Upper India, but in the far more favoured cotton fields of our Presidency, is an adequate testing and full authentication of some inexpensive method of treatment or cultivation, which shall be equally applicable to the exotic, hybridised, and good indigenous varieties, and which the ryots themselves will be able to appreciate alike under their present simple methods of tillage, or under any improved system they may eventually be induced to adopt. There is at last, we think, some prospect of this *desideratum* being attained. The minute of his Excellency suggests more than simply a systematic method of operation in future experiments. It describes what is known at home as *Hallett's pedigree system*, which consists in the selection by hand of the finest seed from each successive year's crop, and the annual reproduction of the plant only from such seed; and it enjoins the adoption of this plan in experiments both with exotic and indigenous cotton, as the best means of acclimatising the one and improving the other. The advantage of this system appears so very manifest that the wonder seems to be that it has never yet been tried. A cultivator selecting the finest bolls in his field of cotton, and putting them aside, extracting from them at leisure the seed for his next sowing, is a thing that has never yet been heard of; but the matter is so simple, so reasonable, that we have little doubt that the system will be generally adopted when the ryots come to be acquainted with it, and its advantages are explained to them." The same article then goes on to say: "The pedigree system was begun last year in different parts of the Presidency, but cannot be said to have yet had to any appreciable extent a trial, as it is obvious that the effect of it can only be judged by the character of the produce of successive years. In the experiments now being conducted in accordance with the plan suggested by His Excellency, there is yet another element of success in the efficient character of the agency employed. The Cotton Departments are assisted in the work by four practical horticulturists, Messrs. Shearer, Stormont, Strachan, and Milne, who have been sent out to this country for the purpose by the Secretary of State, who, we believe, selected them from a number of applicants on the recommendation of Dr. Hooker, of the Botanical Gardens at Kew." I wrote to my friend Sir Joseph Hooker, who, in reply, says the men were sent out from Kew in 1869, but that he has no statement of the results beyond a newspaper cutting, stating that their services were highly approved of, adding, "cotton is coming down from the country much better in quality and in much larger quantities." I therefore wrote to the India Office requesting to be furnished with a copy of the Minute above referred to, and with information as to the exact plan adopted and the results obtained. I can only suppose that there is some difficulty in doing this, as, although I stated that these particulars were required for the Congress this day, they have not yet reached me.

Had the Government, when thus appropriating and applying my system, done me the honour to consult me upon it, I should have pointed out that mere horticulturists, however skilful, would not (unaided) be likely to accomplish very much. It appears that in India there are thirty different kinds of cotton grown, in as many separated districts, for the Liverpool market. In each district the kind of cotton grown there is said to be that most suitable, and indeed the only kind that can be cultivated there with advantage. If this be so, then there must be thirty selectors—one in each district—in order to improve to the utmost the cotton most suitable to it. I do not profess any special knowledge of the growth of cotton, but I know something of the growth of wool, and I apprehend that fineness, and length and strength of fibre are qualities equally desirable in both. I have seen a buyer of wool, when blindfolded, tell by the touch the age and sex of the animal from which the fleece in his hand came, and I have tested beyond all possibility of doubt his ability to do this. I am told there are men in Liverpool who have an equal gift in judging cotton, but that such men soon make their fortunes there. But these are exactly the men who are wanted for cotton selectors in India. The available differences of plants are slight, and when out of a number the selection has reduced the competing plants to two or three, the difference is very slight indeed, but still very real. With many different points to take into account, I have occupied weeks in studying the final best two plants. It is evident that if there is anything at all in selection, a selector, ignorant of the one thing needful, may pedigree in the wrong direction, as the first Napoleon did unconsciously when his conscriptions left only those men who were quite impossible for soldiers to be progenitors of the future Frenchmen with the result of the standard in the army having to be lowered by five inches. I must not, I suppose, be surprised if the Government has imperfectly understood my system when such a man as Mr. Darwin, in his "Cross and Self-fertilisation of Plants," can thus write of it:—"Loiseleur-Deslongchamp (Les Céréales) was led by his observations to the extraordinary conclusion that the smaller grains of cereals produced as fine plants as the large. This conclusion is, however, contradicted by Major Hallett's great success in improving wheat by the selection of the finest grains." Here finest evidently means largest; but size of grain is not even an element in my system of selection.

If then we can seize upon these variations in plants, and by means of the principle of inheritance, perpetuate, increase, and accumulate year by year the original variation in the desired direction, what a field does it open to us for increasing this world's plant food! And how vast is this field compared with that presented by the food-producing animals, in mere number probably not equal to the food-plants upon a single English farm; for while these animals supply food for man alone, and for him only in part, plants may be said to almost wholly support both them and man. Vast, indeed, may this field be called, for it includes not only the plants destined for food and clothing, but also every kind of plant which contributes to the welfare and happiness of mankind; surely a field, then, worthy of any man's labour!

Since this paper was read a Minute by His Excellency, Sir Seymour Fitzgerald, the Governor of Bombay, dated January 10, 1868, has been sent to Major Hallett by the direction of the Secretary of State for India, together with reports extending to 1870 only.

"In England I have had opportunities of seeing on my own land, and on the properties of other gentlemen, how much can be effected in the improvement of cereals by a continued attention during successive years to the selection of the best seed only from crops of a common variety. The pedigree wheat, which bears the name of Mr. Hallett, a Sussex gentleman, is, in fact, a new variety which he has produced by the constant selection each year of the finest ears produced on his farm near Brighton, and by his never permitting any seed from small or inferior ears to be sown. None but the best ears selected by hand were set aside the first year for seed; from the produce of these the best were again in the same manner selected by hand, and this course was continued for several successive years; the final result was the introduction of Hallett's Pedigree Wheat, which I have known in my own experience to produce a crop nearly 50 per cent. more in quantity, and 50 per cent. more valuable in quality, than that produced from the best seed that could be purchased in the market, and this in the same field, under exactly the same circumstances, and with the same care taken in the cultivation.

"I believe the same result may probably be obtained if the same process is adopted with our indigenous cotton. At any rate, I desire the experiment to be carefully made, and will take care that funds are placed at the disposal of the Inspector-in-Chief for this purpose. The experiment should be tried not only in different districts but in several parts of each district, and a sufficient breadth should be sown in each case to ensure a fair and satisfactory trial.

The Inspector-in-Chief is, therefore, authorised to make the same experiments as those I have suggested as to the indigenous cotton—with all the exotic varieties he may receive—in the same manner and on the same scale. Even if they are not successful to the extent and in the manner I anticipate, they will serve to show us, if carefully continued for the next three or four years, what are the exotic varieties of cotton which we can with confidence encourage the cultivators in each district to adopt, as being best suited to the particular circumstances of their lands."

The following extract from Administration Report, Cotton Commissioners' Department, for the year 1870-71, was received by Major Hallett on January 9, 1882. Major A. T. Moore, Acting Cotton Commissioner and Inspector-in-Chief, writes under date Bombay, October 31, 1871, on the advantages of "Selection":—

"Taking everything into consideration, I think the fact of the heavier yield—by more than double—being in favour of the 'Pedigree,' goes to show that 'selection,' as desired by His Excellency Sir Seymour Fitzgerald, should be carefully carried out; that the cultivators should be supplied from the Government crops with as much seed as possible, and at the same time, that the necessity for selection should be earnestly pressed on their notice; while the Superintendents themselves, by carefully and steadily pursuing the same plan year by year, by selecting from all their crops, and again selecting from that selection, will be able apparently, if the present results may be relied on, to increase the production and fruitfulness of the plant, and in the course of a few seasons to establish a veritable 'Pedigree Cotton,' as unlike its parent as the 'English thorough-bred,' with his long stride and fine skin, is unlike the stock whence he originally sprang. It remains for me to notice the avidity with which our surplus seed was purchased by the cultivators. Mr. Wilkinson says this seed was sufficient for the requirements of two villages, and that the crop produced was an abundant one. He further adds, 'I was informed by the Patel of one of the villages that this seed had given great satisfaction; yields being reported of 96 lbs. to 150 lbs. cotton per acre, according to the amount of care in cultivation.' This gives an average of 123 lbs., but I will only take 100 lbs. as the *average* product, and even then I find the figures loudly speaking in favour of carefully picked and selected seed.

	Per acre. lbs.
Average yield of our Departmental seed ...	100
Average yield for Kandeish	$82\frac{2}{3}$
Difference in favour of our seed	$17\frac{1}{3}$
	or about 20 per cent.

If only this 20 per cent. could be established as the increased out-turn, by the efforts of our Department, it would bring wealth to thousands, and unspeakable benefit to the Presidency generally. It would represent an increased produce, valued at last year's rates, of Rs. 26,365,979 = £2,636,597 18*s*. 0*d*.; a result and a prize worth striving for, and, it would appear, possible of attainment!"

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The election to the Professorship of Animal Morphology will take place on May 31.

The Moderators and Examiners for the Mathematical Tripos have announced that logarithmic tables will be provided for each of the candidates during the examination.

The mineralogical laboratory will be open to students during July and August.

The proposed enlargement of the space available at the new museums for Practical Morphology and Histology is to be at once proceeded with.

Mr. W. H. Caldwell, B.A., Scholar of Gonville and Caius College, is approved as a Teacher of Comparative Anatomy with reference to certificates for medical study.

Dr. Anningson has been approved as a teacher of Medical Jurisprudence in the Medical School.

The proposal to continue the opening of the Botanic Garden for three hours on Sundays to Members of the Senate accompanied by their friends during the summer months, has met with warm opposition from some who consider that in this case Sunday labour is imposed on others for the selfish pleasures of a few. It has been pointed out that owing to the value of the contents of the garden it must always be watched, and it could not possibly be said that the proposed regulations will impose additional Sunday labour. The voting on this question takes place to-day (25th).

LONDON.—Prof. Ray Lankester has been re-appointed Professor of Zoology and Comparative Anatomy in University College, London.

SCIENTIFIC SERIALS

American Journal of Science, May.—Photographs of the spectrum of the nebula in Orion, by H. Draper.—Mean annual rainfall for different countries of the globe, by A. Woeikoff.—Physiological optics, by W. L. Stevens.—Flood of the Connecticut River valley, from the quaternary glacier, by J. D. Dana.—Brazilian specimens of Martite, by O. A. Derby.—Method of determining the flexure of a telescopic tube for all positions of the instrument, by J. M. Schæberle.—Dykes of micaceous diabase penetrating the bed of zinc ore at Franklin furnace, by B. K. Emerson.—Occurrence of smaltite in Colorado, by M. W. Iles.—Conditions attending the geological descent of some freshwater gill-bearing molluscs, by C. A. White.—Measures of the rings of Saturn in the years 1879, 1880, 1881, and 1882, by E. S. Holden.—Interference-phenomena in a new form of refractometer, by A. A. Michelson.—New minerals, monatite and monite, with a notice of pyroclasite, by C. U. Shepard.—Marine fauna of New England, by A. E. Verrill.

Journal of the Franklin Institute, May.—On the several efficiencies of the steam-engine, and on the condition of maximum economy, by R. H. Thurston.—Ninety miles in sixty minutes, by W. B. Le Van.—Intonation of chime bells, by J. W. Nystrom.—The Mears chlorination process, by W. U. Greene. Action of charcoal on a solution of gold chloride, by G. E. Kœnig.

Bulletin de l'Académie Royale des Sciences de Belgique, No. 3.—On the sensations the author experiences in his eyes, by M. Plateau.—On a claim of priority, introduced in the Academy by M. E. Dewalque, regarding my note on the origin of Devonian limestones of Belgium, by M. Dupont.—On the respiratory effects of excitation of the pneumogastric, by M. Henrijean.—Various products obtained from fresh stocks of peony; new reaction of salicylic acid, by M. Jorissen.—Reports.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol xv. fasc. vii.—The geology of the Parman Apennines, by A. Del Prato.—The double quadratic transformation of space, &c. (concluded), by F. F. Archieri.—On rational skew curves, by L. Weyr.—On the transformation of the co-ordinates in space, by F. Borletti.

Fasc. viii.—On a formula of Cauchy, concerning the development of functions in infinite products, by P. Cazzaniga.—Whether cemeteries may have an injurious influence on the public health, by L. Gabba.—Remarks on the subject, by C. Zucchi, and reply by L. Gabba.

Atti della R. Accademia dei Lincei, vol. vi., fasc. 10.—On some derivatives of citraconic acid, by Drs. Ciamician and Dennstedt.—Studies on fluoxysalts and fluosalts of molybdenum, by Signors Mauro and Panebianco.—Reports.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 4.—"On the Specific Resistance of Mercury." By Lord Rayleigh, F.R.S., Professor of Experimental Physics in the University of Cambridge, and Mrs. H. Sidgwick.

The observations detailed in the paper were made with the view of re-determining the relation between the B.A. unit and the mercury unit of Siemens, *i.e.* the resistance of a column of mercury at 0°, one metre in length, and one square millim. in section.

According to Siemens' experiments

1 mercury unit = 0·9536 B.A. units,

and according to Matthiessen and Hockin,

1 mercury unit = 0·9619 B.A. units.

The value resulting from our observations agrees pretty closely with that of Siemens. We find—

1 mercury unit = 0·95418 B.A. units.

Four tubes were used to contain the mercury, of lengths varying from 87 to 194 centims. The diameter of the three first tubes was about 1 millim., and that of the fourth about 2 millims. The final numbers obtained from the several fillings of the tubes are as follows:—

Tube I.	0·95386 0·95412 0·95424 0·95436 0·95421	... ... 0·95416
Tube II.	0·95389 0·95414 0·95437 0·95436	... ... 0·95419
Tube III.	0·95424 0·95418 0·95399 0·95425	... ... 0·95416
Tube IV.	0·95440 0·95415	... ... 0·95427

Combining the results of the present paper with our determination of the B.A. unit in absolute measure, we get—

1 mercury unit = $0·94130 \times 10^9$ C.G.S.

Chemical Society, May 18.—Dr. Gilbert, president, in the chair.—The following papers were read:—On the precipitation of the alums by sodic carbonate, by E. J. Mills and R. L. Barr. The authors have determined the quantity of alumina precipitated in one hour from a solution of potash alum containing 1 per cent. of sulphate of alumina by varying quantities of sodium carbonate solution. The precipitation takes place in three stages: in the first no precipitation occurs—at the end of this stage, the ratio is 1 molecule of aluminium sulphate to $\frac{3}{5}$ of a molecule of sodium carbonate; during the second stage precipitation is continuous—at the end of this stage about $\frac{1}{2}$ the alumina is precipitated, the ratio, 1 molecule of the sulphate, to $\frac{3}{2}$ molecule of the carbonate; at the end of the third stage the precipitation is complete, the ratio being 1 molecule of the sulphate to $\frac{12}{5}$ molecule of the carbonate. Similar results were obtained by precipitating potassiochrome alum.—On rotary polarisation by chemical substances under magnetic influence, by W. H. Perkin. The author has determined and compared the power which various organic liquids have of rotating the plane of polarisation, when under the influence of an electro-magnet; and he has calculated the rotary power possessed by the columns of liquids, which would be formed, by the condensation of unit-columns of their vapours, or, in other words, the rotary power possessed by lengths proportional to molecular weight. The numbers thus calculated clearly indicate that the molecular magnetic rotary power increases *pari passu*, with each increment of CH_2.—On the constitution of Amarin and Lophin, by F. R. Japp and H. H. Robinson. By the action of parahydroxy-benzaldehyde upon benzil in presence of ammonia, the authors prepared a substance having the formula of hydroxylophin, which by distillation with zinc dust furnished crystals resembling in all respects the lophin prepared by Laurent, Fownes, &c. Lophin, therefore, belongs to Hübner's anhydrobases, and is an anhydrobenzoyldiamidostilbene.

Geological Society, May 10.—J. W. Hulke, F.R.S., president, in the chair.—Arthur Leech was elected a Fellow, and Prof. L. Rütimeyer a Foreign Member of the Society.—The following communications were read:—On the relations of *Hybocrinus*, *Baerocrinus*, and *Hybocystites*, by P. Herbert Carpenter, M.A. Communicated by Prof. P. Martin Duncan, M.B., F.R.S., V.P.G.S.—On the Madreporaria of the inferior oolite of the neighbourhood of Cheltenham and Gloucester, by R. F. Tomes, F.G.S.—On the exploration of two caves in the neighbourhood of Tenby, by Ernest L. Jones. Communicated by Prof. W. Boyd Dawkins, F.R.S., F.G.S. The caves noticed in this paper were that of Coygan, near Laugharn, partially described by Dr. Hicks in the *Geological Magazine* in 1867, and a cave known as Hoyle's Mouth, reported on to the British Association in 1860 by the Rev. Gilbert N. Smith. Both caves were rock-fissures. The Coygan cave had been a hyæna den, as was shown by the deposits of crushed bones and coprolites trodden down into a solid mass by the passing of the animals. Besides remains of hyæna, it furnished those of horse, mammoth, tichorhine rhinoceros, elk, red deer, roe deer, reindeer, cave bear, cave lion, *Bos primigenius*, wolf, and fox. The presence of hippopotamus was doubtful. Besides these animals, the presence of Palæolithic man in the cave was indicated by some cut bones, and by two flint-flakes evidently chipped by man. In the second cave, Hoyle's Mouth, the hyæna, the cave bear, &c., were wanting, the place of the latter being taken by the common brown bear. In one part, remains of an old hearth were found; and the whole contents of the fissure pointed to a Neolithic date. At one time the cave appears to have been used as a place of sepulture.—Note on the comparative specific gravities of molten and solidified Vesuvian lavas, by H. J. Johnston-Lavis, F.G.S. From some experiments made on Vesuvian lava, Prof. Palmieri, in 1875, expressed the opinion that its specific gravity, when molten, might be as high as 5·0, though when cooled it is only 2·7. The author described the results of experiments made in December, 1881, on some lava flowing across the Atrio del Cavallo. Favourable circumstances enabled him to gain a position above a perfectly molten stream, the surface of which was protected from radiation by the heated walls of a tunnel which the lava had already formed by cooling of the crust. On to this were dropped, from a height of 1½ yard (*a*) light scoria; this floated on the surface until lost to view (the stream could be watched for 150 yards or so); (*b*) fairly solid lava, with some vesicular cavities: this slowly sank, until after some distance it disappeared; (*c*) the most compact lava that could be found, in which, however, were a few small cavities: this sank rapidly, the molten rock welling up round it. The author considered that these experiments demonstrate that the cooled lava is more dense than the molten, and that the apparently contradictory results obtained by Prof. Palmieri were due to the fact that the surface of the stream, by loss of heat, had become viscid, so that the solid material floated, though of greater density. The author concluded by citing other confirmatory evidence of his view.

Entomological Society, May 3.—Mr. H. T. Stainton, F.R.S., president, in the chair.—The president alluded to the interest which the late Mr. C. Darwin, who was one of the original members of the Society, had always shown in entomology.—The Secretary read a communication from the Secretary of the Essex Field Club, relative to the scientific importance of Epping Forest being preserved in its *natural condition* "*unimproved*," and requesting the members to join in a Memorial to the Conservators to this effect, lest it should be converted into a mere park.—Exhibitions: Varieties of *Fidonia atomaria* and *Anchocelis pistacina*, by Mr. W. C. Boyd; a male of *Cryptus titilator*, by Mr. T. R. Billups; a hybrid between *Antheræa Perryi* and *Roylii*, by Mr. W. F. Kirby; and a curious abnormal growth of the flowers of the ash (produced by a gall-mite), by Miss Ormerod. Mr. E. A. Fitch called attention to a woody spherical gall on ash keys, produced by a curmlionideons (?) larva.—Papers read: Further additions to Mr. Mashall's Catalogue of British *Ichneumonidæ*, by Mr. J. B. Bridgman; a continuation of his synopsis of British Hymenoptera, by Mr. E. Saunders; and on the supposed abnormal habits of certain species of *Eurytomidæ*, a group of the Hymenopterous family *Chalcididæ*, by Prof. J. O. Westwood.

Meteorological Society, May 17.—Mr. J. K. Laughton, F.R.A.S., president, in the chair.—Miss W. L. Hall, Mr. E. J. Pearson, Dr. J. R. Somerville, and Mr. W. J. V. Vandenbergh were elected Fellows of the Society.—The following papers were read:—On the diurnal variation of wind and weather in their relation to isobaric lines, by the Hon. Ralph Abercromby, F.M.S. By constructing synoptic charts at different hours of the same day, and by comparing the wind and weather records at the different hours, and examining their relation to mean curves of diurnal variation, the author shows that the mean diurnal increase of the wind's velocity is explained by the fact that for the same gradient there is more wind by day than there is by night. The mean diurnal veering of the wind is explained by the fact that in cyclones the wind is a little more incurved, and in anticyclones a little more outcurved, by night than by day. The mean diurnal increase of the frequency of rain during the day hours is explained by the fact that in any given cyclone the area of rain is larger by day than by night. The diurnal changes of every element are superimposed on the larger general changes, and are independent of each other. Great stress is laid on this point, both as explaining and classifying many meteorological questions, and as simplifying the problem of weather forecasting. The author gives a simple hypothesis, from which it appears that the diurnal veering and increase of rain follow as a natural consequence of the diurnal increase of velocity.—Mechanical conditions of storms, hurricanes, and cyclones, by W. F. Stanley, F.M.S.

Sanitary Institute of Great Britain, May 17.—Annual General Meeting.—Prof. F. S. B. F. Dechaumont, M.D., F.R.S., in the chair.—A favourable report was presented by the council on the progress made by the Institute during the past year. The chairman gave an address, and the officers for the ensuing year were elected, the President being His Grace the Duke of Northumberland, K.G., and the trustees Sir John Lubbock, Bart., D.C.L., F.R.S., Dr. B. W. Richardson, F.R.S., and Thomas Salt.

Institution of Civil Engineers, May 16.—Sir Frederick Bramwell, vice-president, in the chair.—The first paper read was "On the various systems of grinding wheat, and on the machines used in corn-mills," by Mr. W. Proctor Baker.—The second paper was on "Modern Flour-milling in England," by Mr. Henry Simon.—The third paper was on "Roller-mills and milling as practised at Budapest," by Mr. W. B. Harding.

EDINBURGH

Royal Society, May 15.—Prof. Balfour, vice-president, in the chair. Mr. Murray read an account of the explorations which had been carried out by Staff-Commander Tizard and himself in the Faroe Channel during the summer of 1880. In

H.M.S. *Knight Errant* they had taken a series of soundings and dredgings with the view of testing the truth of the theory that a barrier stretched across between the North-West of Scotland and the Faroe bank, separting the cold and warm deep-sea areas which previous exploration had shown to exist in close contiguity to each other. In this they had been quite successful, proving that there was a narrow barrier separating the northern cold area from the southern warm area. From the specimens of rock obtained from the top of this ridge, they concluded that the ridge was in all probability an ancient moraine. The objects, animal and otherwise, brought up from the bottom had been examined carefully by various scientific men, and the paper consisted in great part of their report —sixteen in all.—Mr. E. Sang, in a short notice of the solar eclipse of May 17, laid before the Society calculations which so supplemented for Edinburgh the times and phases given in the *Nautical Almanac* as to make the comparison between calculation and observation more accurate. Should the morning prove favourable for observation, he hoped to be able to lay before the Society the result of the comparison.—Prof. Tait communicated a paper by Mr. A. P. Laurie, on a new secondary cell, with which he had made a long series of experiments. The cell consisted of two copper poles dipping into chloride of zinc, and was charged in the usual manner by running a current through it. Zinc was deposited on the one pole, and cuprous chloride was formed at the other. Even with the small sized cells which were used, the results obtained were tolerably satisfactory. They suffered greatly from loss, however, being in this respect in no way superior to the other known forms of secondary cells.

PARIS

Academy of Sciences, May 15.—M. Jamin in the chair.—The following papers were read :—Observations of small planets with the great meridian instrument of Paris Observatory during the first quarter of 1882, by M. Mouchez.—New note on the project of formation, in Algeria and Tunisia, of a so-called interior sea, by M. Cosson. He brings forward a series of objections to the scheme.—Reply to M. Cosson's note, by M. de Lesseps.—M. Alph. Milne-Edwards presented, in his own name, the second volume of text, and vols ii. and iii. of plates (266 in number) of "L'Histoire Naturelle des Oiseaux de Madagascar." This raises to 400 the number of plates of birds.—Spiraloid drums for cables of equal resistance, by M. Haton de la Goupillière. This relates to extraction from mines. The first part treats of the general properties of every system, of rigorous equilibrium, whatever the form of the cable (cylindrical from end to end, formed of successive cylindrical parts, conical, logarithmic, &c.). In the second part, the general properties arrived at are employed to determine the drum of equilibrium in the case of the logarithmic cable, which represents the exact form of equal resistance. Simple formulæ are furnished for the radii of winding.—Synthesis of several organic compounds by means of electrolysis of water, of acid, alkaline, and alcoholic solutions with electrodes of carbon, by MM. Bartoli and Papasogli. They electrolysed distilled water during about six weeks, using a strong battery (1200 D) the first two days, then 100 Bunsens for ten days, then twenty Bunsens for thirty, the electrodes being carbon. Mixed with the disaggregated carbon was found a dark matter, which they call *mellogen*, because, in oxidation, it produces the acids of the benzocarbonic series. Its other properties are described. Using alkaline solutions (hydrates or carbonates) as electrolytes, the authors got a good deal of mellic acid and very little mellogen ; the reverse being the case where the electrolyte was acid.—On the spherical representation of surfaces, by M. Darboux.—On the conditions of achromatism in phenomena of interference, by M. Hurion. He gives an experimental verification of a principle enumerated by M. Cornu. In a system of interference fringes from heterogeneous light giving a continuous spectrum, there is always an achromatic fringe which plays the part of central fringe, and is found where the most intense radiations present a maximum or minimum difference of phase.—Aperiodic galvanometer of MM. Duprez and d'Arsonval. This is for very weak currents. Between the poles of a horse-shoe magnet set vertically, is a rectangular frame wound with fine wire, connected by two wires, of silver or copper, with a bent support above, and an elastic slip below. These wires, whose tension is regulated by screws, are axial to the frame, to which they also bring the current. The upper wire has a mirror at its lower end ; and within the frame is supported an iron tube to strengthen the magnetic field. The authors indicate a method of graduating galvanometers.—On the length of sparks of the discharge of an electric condenser, by M. Villari. When a condenser is discharged by making it produce one spark or two, the length of the first is not equal to the sum of the lengths of the others, and the sum of lengths of the sparks is not always constant. Small sparks have the effect of elongating another produced at the same time in the circuit ; and this influence grows with the charges of the condenser. It is connected with a sensible diminution of the interior discharge, and increase of the exterior.—Existence of lithine and boric acid in notable proportions in the waters of the Dead Sea, by M. Dieulafait. In a cubic centimetre there is enough lithine to distinctly show, at least a thousand times, the spectrum of that substance. The boric acid can be practically recognised with the product of a single cubic centimetre. These facts (contrary to previous ideas) prove the marine origin of the Dead Sea.—On the laws of solubility of carbonic acid in water at high pressures, by M. Wroblewski. The temperature remaining constant, the coefficient of saturation increases much less quickly than the pressure, while tending to a certain limit. The pressure remaining constant, the coefficient increases when the temperature diminishes.—On the mechanism of putrid fermentation of proteic matters, by MM. Gautier and Etard. The acid fermentation which arises in a few days is an epiphenomenon, not necessary, and not affecting the albuminoid molecules.—On a case of isomerism of bichlorocamphor, by M. Cazeneuve.—On purpurogalline, by MM. de Clermont and Chautard.—On the dimorphism of stannic acid, by MM. Levy and Bourgeois.—On chronic poisoning by arsenic, by MM. Caillot de Poncy and Livon. Cats receiving arsenic in small doses from time to time, eat more, and fatten, for a time, showing every sign of good health ; but by and bye they grow lean, have diarrhæa, lose appetite, and become languid ; and they die in an anæmic and lean state. The authors describe the changes (fatty degeneration) in the lungs, and mesenteric ganglions.—On a disease of early beans in the environs of Algiers, by M. Prillieux. A parasitic champignon produces white wadding-like tufts on the plant.—M. Laussedat said he had seen Mercury with the naked eye on May 11, at 8 p.m.

VIENNA

Imperial Institute of Geology, April 18.—The following papers were read :—C. Doelter, on pyroxenite, a proposal for the classification of the eruptive rocks.—V. Hilber, geological mappings of Zolkiew and Rawa-Ruska (Gallicia).—Th. Fuchs, which deposits are to be considered as of deep-sea origin?

May 2.—T. N. Woldrich, contributions to the fauna of the Istrian breccia.—R. Zuber, geological notes from the Carpathian Mountains of Eastern Gallicia.

CONTENTS

THURSDAY, JUNE 1, 1882

CHARLES DARWIN[1]

III.

THE influence which our great naturalist has exerted upon zoology is unquestionably greater than that which has been exerted by any other individual; and as it depends on his generalisations much more than upon his particular researches, we may best do justice to it by taking a broad view of the effects of Darwinism on zoology, rather than by detailing those numberless facts which have been added to the science by the ever vigilant observations of Darwin. Nevertheless, we may begin our survey by enumerating the more important results of his purely zoological work, not so much because these have been rarely equalled by the work of any other zoologist, as because we may thus give due prominence to the remarkable association of qualities which was presented by Mr. Darwin's mind. This association of qualities was such that he was able fully to appreciate and successfully to cultivate every department and ramification of biological research—whether morphological, physiological, systematic, descriptive, or statistical—and at the same time to rise above the *minutiæ* of these various branches, to take those commanding views of the whole range of nature and of natural knowledge which have produced so enormous a change upon our means of inquiry and our modes of thought. No labourer in the field of science has ever plodded more patiently through masses of small detail; no master-mind on the highest elevation of philosophy has ever grasped more world-transforming truth.

Taking the purely Zoological work in historical order, we have first to consider the observations made during the voyage of the *Beagle*. These, however, are much too numerous and minute to admit of being here detailed. Among the most curious are those relating to the scissor-beak bird, niata cattle, aëronaut spiders, upland geese, sense of sight and smell in vultures; and among the most important are those relating to the geographical distribution of species. The results obtained on the latter head are of peculiar interest, inasmuch as it was owing to them that Mr. Darwin was first led to entertain the idea of evolution. As displaying the dawn of this idea in his mind we may quote a passage or two from his "Voyage of a Naturalist," where these observations relating to distribution are given :—

> "These mountains (the Andes) have existed as a great barrier since the present races of animals have appeared, and therefore, unless we suppose the same species to have been created in two different places, we ought not to expect any closer similarity between the organic beings on the opposite sides of the Andes, than on the opposite shores of the ocean."
>
> "The natural history of these islands (of the Galapagos Archipelago) is eminently curious, and well deserves attention. Most of the organic productions are Aboriginal creations, found nowhere else; there is even a difference between the inhabitants of the different islands; yet all show a marked relationship with those of America, though separated from that continent by an open space of ocean, between 500 and 600 miles in width. The archipelago is a little world within itself, or rather a satellite attached to America, whence it has derived a few stray colonists, and has received the general character of its indigenous productions. Considering the small size of the islands, we feel astonished at the number of their aboriginal beings, and at their confined range. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period, geologically recent, the unbroken ocean was here spread out. Hence, both in space and time, we seem to be brought somewhat near to that fact—that mystery of mysteries—the first appearance of new beings on this earth."

Next in order of time we have to notice the Monograph of the Cirripedia. This immensely elaborate work was published by the Ray Society in two volumes, comprising together over 1000 large octavo pages, and 40 plates. These massive books (which were respectively published in 1851 and 1854) convey the results of several years of devoted inquiry, and are particularly interesting, not only on account of the intrinsic value of the work, but also because they show that Mr. Darwin's powers of research were not less remarkable in the direction of purely anatomical investigation than they were in that of physiological experiment and philosophical generalisation. No one can ever glance through this memoir without perceiving that if it had stood alone it would have placed its author in the very first rank as a morphological investigator. The prodigious number and minute accuracy of his dissections, the exhaustive detail with which he worked out every branch of his subject—sparing no pains in procuring every species that it was possible to procure, in collecting all the known facts relating to the geographical and geological distribution of the group, in tracing all the complicated history of the metamorphoses presented by the individuals of the sundry species, in disentangling the problem of the homologies of these perplexing animals, &c.—all combine to show that had Mr. Darwin chosen to devote himself to a life of purely morphological work, his name would probably have been second to none in that department of biology. We have to thank his native sagacity that such was not his choice. Valuable as without any question are the results of the great anatomical research which we are considering, we cannot peruse these thousand pages of closely written detail without feeling that for a man of Mr. Darwin's exceptional powers even such results are too dearly bought by the expenditure of time required for obtaining them. We cannot, indeed, be sorry that he engaged upon and completed this solid piece of morphological work, because it now stands as a monument to his great ability in this direction of inquiry; but at the same time we feel sincerely glad that the conspicuous success which attended the exercise of such ability in this instance did not betray him into other undertakings of the same kind. Such undertakings may suitably be left to establish the fame of great though lesser men; it would have been a calamity in the history of our race if Charles Darwin had been tempted by his own ability to become a comparative anatomist.

But as we have said—and we repeat it lest there should be any possibility of misstating what we mean—the results which attended this laborious inquiry were of the highest importance to comparative anatomy, and of the highest interest to comparative anatomists. The limits of

---

[1] Continued from p. 75.

this article do not admit of our giving a summary of these results, so we shall only allude to the one which is most important. This is the discovery of the "Complemental Males." The manner in which this discovery was made in its entirety is of interest, as showing the importance of remembering apparently insignificant observations which may happen to be incidentally made during the progress of a research. For Mr. Darwin writes:—

"When first dissecting *Scalpellum vulgare*, I was surprised at the almost constant presence of one or more very minute parasites, on the margins of both scuta, close to the umbones. I carelessly dissected one or two specimens, and concluded that they belonged to some new class or order amongst the articulata, but did not at the time even conjecture that they were cirripeds. Many months afterwards, when I had seen in Ibla that an hermaphrodite could have a complemental male, I remembered that I had been surprised at the small size of the vesiculæ seminales in the hermaphrodite *S. vulgare*, so that I resolved to look with care at these parasites; on doing so I now discovered that they were Cirripedes, for I found that they adhered by cement, and were furnished with prehensile antennæ, which latter, I observed with astonishment, agreed in every minute character, and in size, with those of *S. vulgare*. I also found that these parasites were destitute of a mouth and stomach; that consequently they were short-lived, but that they reached maturity; and that all were males. Subsequently five other species of the genus Scalpellum were found to present more or less closely analogous phenomena. These facts, together with those given under Ibla (and had it not been for this latter genus, I never probably should have struck on the right line in my investigation), appear sufficient to justify me in provisionally considering the truly wonderful parasites of the several species of Scalpellum, as Males and Complemental Males" (vol. i. pp. 292-3).

The remarkable phenomena of sexuality in these animals is summed up thus:—

"The simple fact of the diversity in the sexual relations, displayed within the limits of the genera Ibla and Scalpellum, appears to me eminently curious. We have (1) a female, with a male (or rarely two) permanently attached to her, protected by her, and nourished by any minute animals which may enter her sac; (2) a female, with successive pairs of short-lived males, destitute of mouth and stomach, inhabiting the pouches formed on the under sides of her two valves; (3) an hermaphrodite, with from one or two, up to five or six similar short-lived males without mouth or stomach, attached to one particular spot on each side of the orifice of the capitulum; and (4) hermaphrodites, with occasionally one, two, or three males, capable of seizing and devouring their prey in the ordinary Cirripedal method, attached to two parts of the capitulum, in both cases being protected by the closing of the scuta."

With reference to these Complemental Males (so called "to show that they do not pair with a female, but with a bisexual individual") Mr. Darwin further observes: "Nothing strictly analogous is known in the animal kingdom; but amongst plants, in the Linnean class, Polygamia, closely similar instances abound;" and also that "in the series of facts now given we have one curious illustration more to the many already known, how gradually nature changes from one condition to the other, in this case from bisexuality to unisexuality" (ii. 29).

Lastly, to give only one other quotation from this work, he writes:—

"As I am summing up the singularity of the phenomena here presented, I will allude to the marvellous assemblage of beings seen by me within the sac of an *Ibla quadrivalvis*, namely, an old and young male, both minute, worm-like, destitute of a capitulum, with a great mouth and rudimentary thorax and limbs, attached to each other and to the hermaphrodite, which latter is utterly different in appearance and structure; secondly, the four or five free, boat-shaped larvæ, with their curious prehensile antennæ, two great compound eyes, no mouth, and six natatory legs; and lastly, several hundreds of the larvæ, in their first stage of development, globular, with horn-shaped projections on their carapaces, minute single eyes, filiform antennæ, probosciform mouths, and only three pairs of natatory legs. What diverse beings, with scarcely anything in common, and yet all belonging to the same species!" (i. 293).

Scattered through the "Origin of Species," the "Variation of Plants and Animals under Domestication," and the "Descent of Man," we meet with many purely zoological observations of much interest and importance as such, or apart from their bearing on the general principles and arguments for the illustration or fortification of which they are introduced. In this connection we may particularly allude to the chapters on Variability, Hybridism, and Geographical Distribution—chapters which contain such a large number of new facts, as well as new groupings of old ones, that we cannot undertake to epitomise them in a *résumé* of Mr. Darwin's work so brief as the present. Nor should we forget to mention in the present connection his experimental proof of the manner in which bees make their hexagonal cells, and of the important part played in the economy of nature by earthworms. Moreover, the hypothesis of sexual selection necessitated the collection of a large body of facts relating to the ornamentation of all classes of animals, from insects and crustacea upwards; and whatever we may think about the stability of the hypothesis, there can be no question, from a zoological point of view, concerning the value of this collection as such.

But without waiting to consider further the purely zoological results presented by the work before us, we must turn to consider the effects of this work upon zoological science itself. And here we approach the true magnitude of Darwin as a zoologist. Of very few men in the history of our race can it be said that they not only enlarged science, but changed it—not only added facts to the growing structure of natural knowledge, but profoundly modified the basal conceptions upon which the whole structure rested; and of no one can this be said with more truth than it can be said of Darwin. For although it is the case that the idea of evolution had occurred to other minds—in two or three instances with all the force of full conviction—it is no less certainly the case that the idea proved barren. Why did it prove so? Because it had never before been fertilised by the idea of natural selection. To demonstrate, or to render sufficiently probable by inference the *fact* of evolution (for direct observation of the process is from the nature of the case impossible) required some reasonable suggestion as to the *cause* of evolution, such as is supplied by the theory of natural selection; and when once this suggestion was forthcoming, it mattered little whether it was considered as propounding the only, the chief, or but a subordinate cause; all that was needed to recommend the evidence of evolution to the judgment of science was the discovery of *some* cause which could be reasonably regarded as not incommensurate with *some* of the effects ascribed to it. And, unlike the desperate though most laudable gropings of Lamarck, the simple solution furnished by Darwin was precisely what was required to give a *locus standi* to the evidence of descent.

But we should form a very inadequate estimate of the services rendered to science by Mr. Darwin if we were to stop here. The few general facts out of which the theory of evolution by natural selection is formed—viz. struggle for existence, survival of the fittest, and heredity—were all previously well-known facts; and we may not unreasonably feel astonished that so apparently obvious a combination of them as that which occurred to Mr. Darwin should have occurred to no one else, with the single exception of Mr. Wallace. The fact that it did not do so is most fortunate in two respects—first, because it gave Mr. Darwin the opportunity of pondering upon the subject *ab initio*, and next because it gave the world an opportunity of witnessing the disinterested unselfishness which has been so signally and so consistently displayed by both these English naturalists. But the greatness of Mr. Darwin as the reformer of biology is not to be estimated by the fact that he conceived the idea of natural selection; his claim to everlasting memory rests upon the many years of devoted labour whereby he tested this idea in all conceivable ways—amassing facts from every department of science, balancing evidence with the soundest judgment, shirking no difficulty, and at last astonishing the world as with a revelation by publishing the completed proof of evolution. Indeed, so colossal is Mr. Darwin's greatness in this respect, that we doubt whether there ever was a man so well fitted to undertake the work which he has so successfully accomplished. For this work required not merely vast and varied knowledge of many provinces of science, and the very exceptional powers of judgment which Mr. Darwin possessed, but also the patience to labour for many years at a great generalisation, the honest candour which rendered the author his own best critic, and last, though perhaps not least, the magnanimous simplicity of character which, in rising above all petty and personal feelings, delivered a thought-reversing doctrine to mankind, with as little disturbance as possible of the deeply-rooted sentiments of the age. In the chapter of accidents, therefore, it is a singularly fortunate coincidence that Mr. Darwin was the man to whom the idea of natural selection occurred; for although in a generation or two the truth of evolution might have become more and more forced upon the belief of science, and with it the acceptance of natural selection as an operating cause, in our own generation this could only have been accomplished in the way that it was accomplished; we required one such exceptional mind as that of Darwin to focus the facts, and to show the method.

It seems almost needless to turn from this aspect of our subject to enlarge upon the influence which a general acceptance of the theory of descent has had upon biology. We do not state the case too strongly when we say that this has been the influence which has created organisation out of confusion, brought the dry bones to life, and made all the previously dissociated facts of science stand up as an exceeding great army. Let any one turn to the eloquent prophecy with which the pages of the "Origin of Species" terminate—a prophecy which sets forth in order the transforming effect that the doctrine of evolution would in the future exert upon every department of biology—and he may rejoice to think that Mr. Darwin himself lived to see every word of that prophecy fulfilled. For where is now the "systematist . . . incessantly haunted by the shadowy doubt whether this or that form be a true species"? And has it not proved true that "the other and more general departments of natural history will rise greatly in interest—that the terms used by naturalists, of affinity, relationship, community of type, paternity, morphology, adaptive characters, rudimentary and aborted organs, &c., will cease to be metaphorical, and will have a plain signification?" Do we not indeed begin to feel that "we no longer look at an organic being as a savage looks at a ship, as something wholly beyond his comprehension; and when we regard every production of nature as one which has had a long history, when we contemplate every complete structure and instinct as the summing up of many contrivances, each useful to the possessor, in the same way as any great mechanical invention is the summing up of the labour, the experience, the reason, and even the blunders of numerous workmen, when we thus view each organic being," may we not now all say with Darwin, "How far more interesting—I speak from experience—does the study of natural history become?" And may we not now all see that "a grand and almost untrodden field of inquiry on the laws of variation, on correlation, on the effects of use and disuse, on the direct action of external conditions" *has* been opened up; that our classifications, *have* become "as far as they can be made so, genealogies, and truly give what may be called a place of creation;" that rules of classifying *do* "become simpler when we have a definite object in view;" and that "aberrant species, which may fancifully be called living fossils," actually *are* of service in supplying "a picture of ancient forms of life?" And again, must we not agree that "when we can feel assured that all the individuals of the same species and all the closely-allied species of most genera, have, within a not very remote period, descended from one parent, and have migrated from some one birth-place; and when we better know the many means of migration, then, by the light which geology now throws, and will continue to throw, on former changes of climate and of the level of the land, we shall surely be able to trace in an admirable manner the former migrations of the inhabitants of the whole world?" And who is now able to question that "by comparing the differences between the inhabitants of the sea on the opposite sides of a continent, and of the various inhabitants on that continent in relation to their apparent means of migration, some light can be thrown on ancient geography?" Or, if we turn to "the noble science of geology," do we not see that we are beginning "to gauge with some security the duration of intervals by a comparison of the preceding and succeeding forms of life?" And last, though not least, have we not found this one short sentence so charged with meaning that a new and extensive science, second in importance to none, may be almost said to have grown out of what it states:—"Embryology will often reveal to us the structure, in some degree obscured, of the prototypes?'"

If the progress of science during the last two-and-twenty years has in so astonishing a measure verified the prophecy of the "Origin of Species," surely, in conclusion, we are more than ever constrained to agree with the sentiments expressed by its closing words:—"When I view all beings, not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Cambrian system was deposited, they seem to me to become ennobled. . . . There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

(*To be continued.*)

ECLIPSE NOTES[1]

III.

THE eclipse of 1882 is now over, and it is not too much to say that the observations have been most successful. Much more work has apparently been done in former eclipses, but it has been of a far more general nature, and, as the old saw has it, *dolus latet in generalibus*. This year the work has put on very much more of a quantitative look, and each observation therefore more or less means a real step in advance. And indeed the time had come when this should be so, for day by day the quantity of laboratory work done which can be more or less compared with eclipse observations is increasing, and in the case of general observations either in one case or the other comparisons are impossible. I have taken many prior occasions of insisting upon this point; but perhaps the reason why this principle has been so generally acted upon on the present occasion has been a capital example set to future eclipse parties. Some days before the eclipse there was a regular Congress of the leaders of the different expeditions and the chief observers, held under the presidency of Mahmoud Pacha, the astronomer at Cairo, and not only was the general plan of observations agreed upon but the necessity of a limited field of inquiry was generally acknowledged; hence at the moment of the eclipse each worker had only a limited part of the spectrum to study, and the instrument to be employed whatever its form, and there were many forms employed, was carefully prepared for this part, and this part only, before totality.

In the way of dispersion, MM. Thollon and Trépied outdistanced all their *confrères*, as each had the most powerful form of Thollon spectroscope yet constructed. The dispersion in this instrument is about the same as that given by a Rutherfurd grating (of 17,000 lines to the inch) in the third order, with this important difference, that the quantity of light is much greater, so that a spectrum can be much better observed. With these spectroscopes, object-glasses of 9 inches aperture, and siderostats of a simple altazimuth focus were employed. All the other spectroscopic arrangements, whether for eye or photography, were mounted on equatorial stands. The instruments employed for exposing the rapid plates, which recent progress in photographic science has placed in the hands of the astronomers, were perhaps the most complicated Thus we had a camera with large lens some 5 feet focus; on this a slitless spectroscope of the Fraunhofer form, similar to that employed in Siam in 1875, but with a prism of greater angle in front of the object-glass then a tele-spectroscopic camera of small dispersion with small image of the sun in the slit, and last of all an ordinary camera of small focus.

Perhaps before I go further it will be convenient to give a collective note agreed upon in a second congress held two hours after the eclipse. This will show the *general* opinion as to the general results.

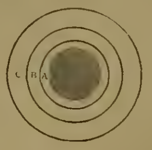
"Unprecedented facilities afforded by Egyptian Government for observation of the eclipse. The plan carried out was agreed upon by the members of the English, French, and Italian expeditions. The accord among the results is very satisfactory. Photographs of the corona and of its complete spectrum were obtained by Schuster on Abney's plates, H and K being the most intense lines. A study of the red end of the spectrum of the corona and prominences was made by Tacchini. A comet which was very near the sun, and a very striking object, was photographed and observed with the naked eye. Bright lines were observed before and after totality of different heights by Lockyer, and with intensities differing from the Fraunhofer lines by Lockyer and Trépied. An absolute determination of the place of the coronal line at 1474, of Kirchhoff's scale, was made by Thollon and Trépied. The absence of dark lines in the corona spectrum was noted by Tacchini and Thollon with very different dispersions. Many bright lines in the violet were observed in the spectrum of corona by Thollon, and were photographed by Schuster. Hydrogen and coronal lines studied in grating spectroscope by Puiseux, and in direct-vision prism by Thollon. Rings observed with grating by Lockyer, first, second and third orders. Continuous spectrum relatively fainter than in 1878, and stronger than in 1871. Intensification of absorption observed in group A at the edge of the moon by Trépied and Thollon.

"LOCKYER, TACCHINI, THOLLON."

Having given the collective note, I may be permitted to refer first to those observations which specially bear upon the matter dwelt upon in these notes—observations touching the bright lines seen before and at the moment of totality.

The importance of this part of the work arises from the following considerations:—If there be a layer of a certain height, by the absorption of which the lines of Fraunhofer are reversed, the lines visible under the stated conditions during eclipses will all be of the same height, and their intensities will all be those of the Fraunhofer lines; if, on the contrary, the reversing layer is a myth, as I believe it to be from a consideration of all the prominence and spot work done up to the present time, the lines will not be all of the same height, and the intensities will widely differ from those of the general spectrum of the sun, for the following reasons:—

As explained in my first batch of notes, it is most probable that the solar spectrum is built up of the absorption of different layers, and not of one, thus—



A, B, C, layers.

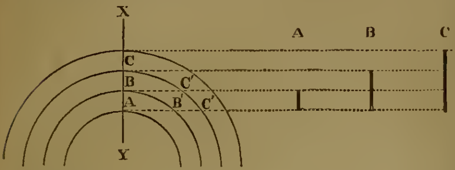
A, layer nearest the sun, and therefore hottest, and

---

[1] Continued from p. 52.

therefore probably best represented in prominence-spectrum. B and C, layers further from the sun, and therefore cooler, and therefore probably best represented in spot-spectrum.

If this be so, when we can see the lines of these layers we shall see something like this—



The lines of A—the hottest layer—will be brightest and shortest.

The lines of B—the next cooler layer—will be less bright and longer, and will also go down to the sun, on account of the part of the layer at B, although it is unrepresented at A, along the section X—Y.

And so on with C.

In an eclipse we have a condition in which the atmospheric light is gradually withdrawn. The lines should appear, therefore, in the order of their lengths; that is, the line which turns out to be longest should be the last to appear, and this is a magnificent proof that the substance which produces the line does not extend down to the sun, for if it did it should be brightest at bottom, and should at first appear as a short line.

Now what were the facts? Dealing with the region between F and *b*, and not all of that, and especially with the three iron lines I have so often mentioned, this was the order of appearance—

May 17, 8.18 a.m., saw F and T_1 very short.

(T_1 meaning the single iron line of the three *wl* 49233 so constantly seen by Tacchini in prominences).

8.19 ... F + T_1 + 4933 short.
8.20 ... F + T_1 + 4933 + *b* long.
8.23 ... F + T_1 + 4933 + *b* + T_2 short.

(T_2 meaning a high temperature iron line at *wl* 50176, constantly seen by Tacchini with 49233).

At this time the darkness sensibly decreased, and then for the first time several long thin lines suddenly burst out.

8.23.30: Single iron line at 49565, and double at 4918 and 49195 and line at 49325, the last three being the longest. Other long lines made their appearance, but their positions were not absolutely determined.

Totality was announced at 8h. 25m. 42s., and it was arranged that I should then change my instrument. I fancy the signal was given a little too soon, for when I went to my $3\frac{3}{4}$ telescope to study the structure of the corona the cross wires were still some distance from the point at which the sun disappeared; but be this as it may, I missed the flash, but this was unimportant, the real work was done. Still this is a point so crucial that we ought not to be satisfied till all these changes, even including the flash, have been photographed on a moving photographic plate, an idea which struck me too late for utilisation during the present eclipse.

Next, as to the structure of the corona. Again the predictions were fulfilled; we were in presence of a repetition of the eclipse of 1871; everything special to that of 1878 had disappeared. There was absolutely no structure near either pole. I was using the same telescope as in 1878, when this feature was so marked, so there can be no mistake on this point. The filamentous character of the streamers, a marked feature in 1871, was however not so decided.

As with the structure so with the ring spectrum. The rings so bright in 1871, so conspicuously absent in 1878, were again visible, but with a Rutherfurd grating they were not so obvious as I at all events expected to find them. As seen at mid-eclipse, 1474 was the faintest ring, and C the brightest.

With regard to the spectrum of the corona as seen with an ordinary tele-spectroscope, arranged to give as much light as possible, I have not so much to say as I had hoped, for the reason that the totality lasted longer than we counted upon. The result of all the preliminary *pourparlers* had been to fix upon sixty-five seconds as the most probable duration of totality, or rather as the duration to be provided for especially from the photographic point of view, since a photograph exposed during totality would be ruined if the sun reappeared before the cap of the camera had been replaced. Sixty-five seconds having elapsed from the announced commencement of totality, I went to the corona spectroscope which I should have gone to ten seconds earlier (but the comet had taken five seconds, and the grating observation had been more uncertain than I had expected) At the moment I made the observation the eclipse was over, but still I noted F, and 1474, and C, bright, and extending right across the field, and a *banded spectrum*, that is to say, not a continuous spectrum certainly, but into maxima and minima, though the minima gave no signs of dark lines. The observation, however, was almost instantaneous, and too much importance must not be attached to it.

Here my notes must close for the present; 104° in the shade is not conducive to writing, even if camels were not growling, and flies teasing, as they can tease in Egypt.

J. NORMAN LOCKYER

Siout, May 21

(*To be continued.*)

BIOLOGY AND AGRICULTURE

RECENT advances in our knowledge of the lowest forms of life have tended to bring into prominence not only their relation to disease but to the ever-increasing importance of the part which they play in our arts and industries. Probably in none of the industrial arts, save those concerned with fermentation, commonly so called, has the progress of this branch of biology shown such remarkable development as in its bearing on the art of agriculture.

It has even been suggested that a *bacterium* is at the bottom of the present state of agricultural depression, and there is a considerable amount of force in this suggestion. The loss of nitrogen from the soil in the form of nitrate is one of the most serious difficulties with which the farmer has to contend; and, as this loss takes place by the washing out of nitrates in the drainage and its diffusion into the subsoil below the reach of the roots of plants, it is necessarily greater in wet seasons such as have been the rule for the last few years.

We believe that Pasteur was the first to suggest, twenty years ago, that the process of nitrification going on in soils and waters might be due to the agency of an organism; but it was not until the last five years that the researches of Schlösing and Müntz and of Warington conclusively showed that this is the case and that the organism is a *bacterium*. This *bacterium* is present in all fertile service soils and under the proper conditions of temperature, moisture, supply of oxygen, and presence of salifiable base is continually converting ammonia and nitrogenous organic matter, which has passed the putrefactive stage, into nitrates. That nitrates are the chief form from which most crops and especially the cereals assimilate their nitrogen is now admitted generally, even by the few physiologists who still cling to the belief that plants can assimilate free atmospheric nitrogen; the very great use of this nitrifying organism is thus apparent. It may be remarked in passing that this Schizomycete is able to effect a change in a mineral substance, ammonia, causing its oxidation into nitric acid, all other known organised ferments being concerned in the transformation of organic bodies, and this is an operation hitherto unsuspected in the life of any Bacteria.

Nitrification takes place in soils most rapidly in the hot months of the year, and as a cereal crop assimilates little or no nitrogen after June, but merely transfers that already taken up and present in the roots, stems and leaves to other organs, it follows that, on a cornfield, in the late summer and the autumn months, nitrates will be formed and, will, in the event of wet weather, be readily washed out of the soil.

Observations made during many years at Rothamsted, and recently published by Messrs. Lawes, Gilbert, and Warington,[1] show the extent to which this loss of nitrates may occur. They find that on land uncropped and unmanured, that is, a bare fallow, during 4 years 1878-1881, nearly forty-two pounds of nitrogen per acre per annum, equal to nearly two and a half hundredweight of ordinary nitrate of soda, was lost by drainage. They also estimate that on land under continuous wheat cropping from ten to twelve pounds of nitrogen per acre per annum was lost by drainage from plots which received no nitrogenous manure. When nitrogen is applied in the manure, considerably larger quantities are lost in the drainage, and this is exclusive of that diffused into the lower layers of soil below the reach of plant roots, and of that which may under certain conditions be lost by deduction to elementary nitrogen.

In an ordinary rotation the loss of nitrogen will be considerably less than in these experiments, for crops will often be growing for months after the cereal crop is removed, and thus conserve the available nitrogen and store it up for future use. It is however obvious, that, with a bare fallow favouring the production of nitrates, followed by a wet season, a very considerable loss of available nitrogen will occur through loss of nitrates, and it becomes a matter for the farmer to consider whether it is to his advantage, for the sake of cleaning his land, to take the risk of this loss and supply the nitrogen at a cost, in ammonia, salts, or Chili saltpetre, of nearly a shilling per pound, or on the other hand, adopt some system of cultivation and cropping by which much of the loss may be obviated. On some soils the growth of an autumn green crop would save most of the nitrates and leave the land in fair condition for a succeeding crop; naturally the decision as to the advisability of such a course must rest in each case with the individual farmer.

The Agricultural mind appears to always require a panacea from the scientific man before it will accept his results as of any use. At a recent meeting of the Farmers' Club it was observed by a leading agriculturist, that, although Mr. Lawes (now Sir J. B. Lawes) had discovered the way in which nitrogen was lost, he had not told the farmer how to retain the goods effects of nitrogenous manures in adverse seasons. The discovery of the manner in which the loss occurs is, however, an immense step in the right direction, and moreover Lawes and his colleagues have clearly shown that with a growing crop on the land the loss is very greatly lessened.

This *bacterium* of nitrification is but one of a great number of the lower forms of life now engaging the attention of scientific men, which are, or ought to be, of immense interest to the scientific pursuit of agriculture. The researches of Pasteur on the life history of *Bacillus* of Anthrax, Aitken and Hamilton's investigations now being conducted into the causes producing braxy and louping ill; and the study of the organisms concerned in the changes which occur during the souring of milk and the ripening of cheese are kindred studies bearing in a direct manner on the daily practice of the farmer. Of no less interest too is the biological work done by Kühn and Liebscher, which has traced the *beet sickness* to the presence of a Nematode, while the investigations into the life history of *Hemileia vastatrix*, the too well-known coffee leaf disease, the *Plasmidiophora*, which is the proximate cause of *anbury* in turnips, and the fungus of potatoe disease, all point to the growing relation between the kindred sciences of biology and agriculture. Illustrations might be multiplied almost indefinitely but these are of sufficient importance to show that the work of the microscopist and biologist has a wide and deep influence, first of all on the practice of agriculture, and through it on the comforts and the pockets of the consumers at large.

THE TRANSIT OF VENUS, 1874

Account of Observations of the Transit of Venus, 1874, *December* 8, *made under the Authority of the British Government*. Edited by Sir George Biddell Airy, K.C.B., Astronomer-Royal.

THIS volume, recently published under the authority of the Treasury, contains the official account of observations of the last transit of Venus, by the five expeditions organised at the public expense and the reduction of the observations.

In an Introduction Sir George Airy briefly recapitulates the various steps taken by himself with the view to the efficient observation of this phenomenon, from his first communication to the Royal Astronomical Society in April, 1857, "On the means which will be available for correcting the measure of the sun's distance in the next

---

[1] *Journal of the Royal Agricultural Society* [2] xvii. and xviii.; and *Journal of Society of Arts*, April 7th, 1882.

twenty-five years." His official correspondence with the Admiralty commenced in October, 1868; the early proceedings were reported to the House of Commons in July, 1869, and after much public discussion a statement on the general plan was made to the House in March, 1873. The collection of an efficient body of observers was then proceeded with, Colonel (then Captain) Tupman, R.M.A., who was one of the first to offer his services, taking an active part, on the recommendation of Sir George Airy, in the arrangements for the expeditions made under the authority of the Admiralty, and it may be stated here that since his return all the observers were placed under his superintendence at the Royal Observatory, for completing their special share in the reductions. He examined every step in the observers' computations, especially all that related to the adjustments of the instruments. "Never perhaps," says Sir George, "was such an enormous mass of calculations so severely criticised, and where necessary, repeated." In the latter part of 1880, the calculations with portions of introduction for each station, were handed over to Sir George Airy, by Captain Tupman, who was about to leave the country, and the remainder of the work was performed under the immediate guidance of the Astronomer-Royal, who states that it had occupied all the hours, not engaged on routine business, on which he could usually have reckoned for other matters of science.

The volume is divided into five parts, referring to as many expeditions for the observation of the transit, with an appendix. Part I. treats of the expedition to the Sandwich Islands, and the observations at Honolulu, Kailua, and Waimea; II. the expedition to Egypt (Mokattam Hills, near Cairo and Suez); III. that to Rodriguez, and the observations at Point Venus, Point Coton, and Hermitage Islet; IV. that to Kerguelen Island, and observations at Observatory Bay, Supply Bay, and Thumb Peak; and Part V. details operations in New Zealand. The observations and reductions in the expedition to the Sandwich Islands are printed at much length, but particulars relating to the other expeditions were presented on the scale which Sir George Airy had proposed in an address to the Royal Astronomical Society in March, 1875. It is hardly necessary to say that the actual observations of the transit are given *in extenso*, with full descriptions of the determinations of longitude, whether by telegraph, runs with chronometers, or lunar observations with the transit or alt-azimuth, to which last method Sir George Airy had called early attention, as one which it might be essential to apply in certain cases. The reduction of the observations is carried to the formation of the equations of condition, from which the parallax, &c., have to be determined. Sir G. Airy says he has "endeavoured to give the equations in the shape that will admit of combination in the easiest way for the computer's further operations—(whether he may desire to use the Calculus of Probabilities for the whole, or to make any special selection of combinations)—when he shall have decided on the recorded phase of contact of limbs which he thinks best to adopt."

The Appendix contains some tabular details and an account of photographic observations of the transit. The photographs are preserved at the Royal Observatory, and Sir G. Airy considers it possible that some astronomer may deem them worthy of rediscussion, though he does not anticipate that any great improvement can be made in measuring them.

This important volume, which extends to over 500 pages, is printed for Her Majesty's Stationery Office.

OUR BOOK SHELF

Worked Examination Questions in Plane Geometrical Drawing. By F. E. Hulme, F.L.S., F.S.A. (London: Longmans.)

THE Art Master at Marlborough College has gathered together in this book 300 problems, chiefly from papers set at the examinations for entrance to the military colleges. He gives fully worked out solutions to two-thirds of the questions, leaving the student to exercise himself unaided with the remainder. The figures embodying the solutions seem to have been very carefully prepared, and are clearly printed, and each plate is furnished with a blank fly-leaf, making reference easy.

A fair knowledge of geometry is assumed, but to certain of the questions notes are appended on special points as they arise, such as might not have been dealt with in the text-book or course that the student has worked through. These notes are very good, and not too long; the author's experience enabling him to anticipate difficulties and to give warning against pitfalls. Especially is the attention of the student drawn to constructions which, though they do not involve much head knowledge, yet require great care to ensure accuracy, and are thus severe tests of neatness and power in the use of instruments. In view of the growing importance of graphical methods of obtaining numerical results, the acquisition of this sort of hand-skill is becoming every day more desirable.

This book will be a welcome addition to the appliances of all teachers of the subject, for it will help to fill a wide gap; still the author might have made it more generally useful by a more judicious arrangement of his materials. The current text-books resemble treatises on arithmetic with very few examples: this volume furnishes an admirable collection of miscellaneous examples, but they are neither graduated nor classified; and they are too numerous for use by ordinary students *after* going through a systematic course of instruction in the subject. Teachers will know how to use the materials here provided whilst developing the subject, but their labour would be lightened, and the book made more serviceable for private students, by a classified table of contents or index to the problems. A. R. W.

Contributions to the History of the Development of the Human Race. By Lazarus Geiger. Translated from the second German edition by Daniel Asher, Ph.D. (Trübner and Co.)

THE firm of Trübner and Co. has done well in admitting this translation as a member of its *Philosophical Series*. The work is a thoughtful contribution by an able linguist to the science of anthropology as elucidated by the study of language. It is full of interesting facts and suggestive ideas concerning each of the following subjects, which form the headings of the six chapters of which the work consists:—The importance of language in the development of the race, the earliest history of the race as elucidated by language, the colour-sense of primitive times, the origin of writing, the discovery of fire, and the primitive home of the Indo-Europeans.

The Brain and its Functions. By J. Luys. International Scientific Series, vol. xxxvii. (London: Kegan Paul and Co., 1881.)

WE consider this a disappointing book, whether we regard it from a physiological or a psychological point of view.

It adds nothing, either to our previous knowledge of facts, or to our previous conceptions with regard to them, and so is of no use to scientific readers; while the manner in which it treats its subject is so dreary that we fear it is no less ill adapted to the requirements of popular readers. We regret this failure the more because the author, as is well known, is so hard a worker, both in cerebral morphology and morbid psychology, that in writing this book he deserved a success which he has failed to achieve. Having said this much it seems needless to enter on any detailed criticism. We have forced ourselves to read the work from end to end, but cannot advise any one else to follow our example.

Ideality in the Physical Science. By Benjamin Peirce. (Boston: Little, Brown and Co., 1881.)

THIS work is a series of six lectures published posthumously by the author's son. The lectures are of a purely popular character, and their object throughout is to maintain that science is, so to speak, an intellectual handmaiden to Christianity. The arguments, or rather illustrations, are all drawn from the domain of physics and astronomy, of which the writer was himself so distinguished a cultivator, and every page glows with the fervour of a deeply religious mind. Indeed, we may question whether there is not rather too much of this, even in view of the emotional effects which it seems to be the main object of the speaker to produce. The intellectual or argumentative object throughout is to show that the "ideality in the physical sciences" points to ideation in the source of the physical universe, or, to quote the concluding paragraph: "Judge the tree by its fruit. Is this magnificent display of ideality a human delusion, or is it a divine record? The heavens and the earth have spoken to declare the glory of God. It is not a tale told by an idiot, signifying nothing. It is the power of an infinite imagination, signifying IMMORTALITY."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Mr. Charles Darwin's Letters

WILL you allow me to mention that I am collecting my father's letters with a view to a biography. I shall be much obliged to any of my father's friends and correspondents who may have letters from him, if they will kindly allow me to see and make copies of them. I need hardly add that no letter shall be published without the full consent of its owner.

Down, Beckenham, May 25 FRANCIS DARWIN

Comet (*a*) 1882

THE following observations of Comet (*a*) 1882 have been made with the Transit-Circle of the Radcliffe Observatory, Oxford, when passing *sub-polo*:—

	1882.	G.M.T. h. m. s.	Observed R.A. h. m. s.	Observed N.P.D. (uncorrected for parallax). ° ′ ″	Observer.
(*a*)	May 12,	8 57 20·13	0 14 22 90	15 32 53·4	R.
(*b*)	13,	9 18 33·31	0 39 36·12	15 54 2·9	W.
(*c*)	15,	9 57 21·31	1 26 23·60	17 8 33·8	R.
(*d*)	16,	10 14 15·71	1 47 17·34	18 0 13·7	W.
(*e*)	17,	10 29 20·28	2 6 20·93	19 0 10·5	R.
(*f*)	18,	10 42 34·30	2 23 33·69	20 7 31·7	W.
(*g*)	19,	10 54 4·86	2 39 2·69	21 21 18·8	R.
(*h*)	20,	11 3 59·82	2 52 55·84	22 40 44·3	W.
(*i*)	21,	11 12 28	3 5 (22)	24 5 (18)	R.
(*k*)	22,	11 19 38·70	3 16 30·40	25 33 (54)	R.

Observers' notes:—

(*a*), (*b*) Very faint; but observations fair.

(*c*) Very faint at times; observation fair on the whole.

(*d*) Nucleus sometimes showed as a bright point, but generally not so well defined, and would scarcely stand any illumination of field. Observation, though difficult, very fair.

(*e*) Observation good.

(*f*) Observation considered very good. Nucleus very sharp at times.

(*g*) Difficult, but observation considered fairly good. Nucleus faint at times.

(*h*) Faint. Observation good.

(*i*) Observation only approximate. Sky cloudy.

(*k*) R.A. good. N.P.D. very rough, from a single bisection when extremely faint.

General Notes:—In the telescope, the light of the head on the night of May 18, the nucleus being better defined than on any other night when the observations were made by me, was certainly not brighter than an eighth magnitude star (W.).

Brightness = Eight in star-magnitude (R.).

Observers—W. = Mr. Wickham.
R. = Mr. Robinson.

E. J. STONE

Sea-shore Alluvion—Calshot and Hurst Beaches

WESTWARD of Brighton; Shoreham Harbour, Portsmouth, Southampton, and the Solent roadstead, all derive protection from shingle moles thrown up to windward of their entrances, the most remarkable of which, Calshot and Hurst Points, have each one of Henry VIII.'s stone castles at their extremities. The first incloses a large tidal estuary (Owers Lake) at the entrance to Southampton water, and forms a pier covering the entrance to that fine natural harbour from the south-west.

The condition of this spit is not much altered since Leland's time, A.D. 1539; it terminates in a horn, which forms the lake, and the outfalls of the Beaulieu and Lymington Rivers westward have similar windward moles on a modified scale.

Hurst Point is two miles in length in a north-west and south east direction, formed of rounded siliceous pebbles on an argillaceous base, which last terminates in a nearly perpendicular submarine cliff 200 feet in height; this physical peculiarity of position has been described by Webster and other writers; it has for centuries acted as a breakwater to the Solent and the small natural harbours eastward of it on the Hampshire coast, but has also limited their capacity by promoting a rapid deposition of silt along their foreshores. In the storm of November, 1824, its position was, and remained for some time, considerably altered, as has been described by Lyell. Still, however, the maps in the Cottonian and Burleigh collections all show the peculiar horn-like termination due to the indraught into the Solent, and the general outline of the spit much as at present, which doubtless has preserved its main features for centuries, subject, however, to local disturbance and variation. Half a mile landward of the lighthouses the beach curves eastward, and forks into three or four gradations of "fulls," showing modern variations and additions to the extremity locally termed the "Point of the Deep," a quarter of a mile long, and running nearly at right angles to the main mole; two smaller spits called "Rabbit Point" and "Shooting Points" (a double formation), tail out from the main spit, within or landward of the extremity.

Parallel to the entrance to the Solent, a bank of shingle three to four miles in length, with about six feet water over it at low water of spring tides, varying in level with the weather, easterly winds banking it up, stretching from the extremity of Hurst Point, south-westward to opposite the ledge called the "Bridge," off the "Needles" rocks, leaves the small entrance channel (the "Needles" Channel) intervening.

Hurst Beach presents many characteristics peculiar to the Chesil, Calshot, and other similar formations such as a low, flat shore to leeward or eastward, and a highly-inclined beach seaward, with a tendency to curve round north-eastward, and ultimately to inclose a tidal mere or lake; the elevation and size of the pebbles increase towards the summit and termination, and in places patches of sand and shingle conglomerate of an early date crop out through the shifting modern "fulls."

The degradation of the cliffs to the westward has been very great, and they are much serrated and water-worn, with frequent slips in the upper strata of sand and gravel on a clay base, and in the neighbourhood of Hordle huge masses of fallen cliff alternate with hollow chines. At Barton also the loss is great, averaging over certain periods one yard per annum, and the whole frontage of Christchurch Bay is similarly affected.

The shingle immediately westward of Hurst becomes smaller, as is universally the case with these spits. Hurst Beach in effect, with alternating withdrawals and renewals, due to change of wind, represents by its height and the size of its pebbles the general leeward accumulating drift.

General observation leads to the conclusion that littoral shingle travels mainly along the shore, as in all cases the coarse pebbles are succeeded by fine shingle, and this ultimately, by sand, silt, or clay; but that spits of shingle grow out into deep water, creating a base for themselves the numerous nesses on our coasts amply show; but before arriving on the shore that shingle does travel at very considerable depths is shown by such cases as the above-mentioned submarine shingle bank west of the Needles passage and the "Boulders" off Selsea Bill.

Here the "Park Anchorage" eastward of the Bill is the traditional site of the bishop's see, and hydrographic authorities cited in the English Channel Pilot describe the gravel bottom as rough and thinly covering a strong clay. J. R. REDMAN

6, Queen Anne's Gate, Westminster, S.W., May 18

Difficult Cases of Mimicry

IN the very interesting communication by Mr. Wallace, in NATURE, *ante* p. 86, on some difficult cases of mimicry, there is one statement which apparently challenges comment.

Mr. Wallace states that although it has been so suggested, it is highly improbable that young birds have a hereditary instinct enabling them to distinguish uneatable butterflies antecedent to experience. Mr. Wallace has not alluded to the very thorough and careful experiments made by the late Mr. Dougl. A. Spalding on this point. It is unnecessary to refer to the results obtained by Mr. Spalding in proving the inherited acquisition of ideas and experience in young chickens, it will at least suffice to repeat the observations made by him, on the actions of a young turkey which he had adopted—"When chirping within the uncracked shell." Now this young turkey, not only on the tenth day of its life, exhibited the most intense terror at the sound of a hawk's voice which was confined in a cupboard but also proved its *inherited* knowledge of uneatable insects.

"When a week old my turkey came on a bee right in its path—the first, I believe, it had ever seen. It gave the danger chirp, stood for a few seconds with outstretched neck and marked expression of fear, then turned off in another direction. On this hint I made a vast number of experiments with chickens and bees. In the great majority of instances the chickens gave evidence of instinctive fear of these sting-bearing insects, but the results were not uniform, and perhaps the most accurate general statement I can give is, that they were uncertain, shy and suspicious."

If domesticated fowls and turkeys exhibit such inherited "instinct," may we not postulate a much greater excess of the same in purely insectivorous birds in a state of nature. And if this is so, it will be unnecessary to explain away, what appears to be one of the most philosophical considerations in the doctrine of "mimicry." W. L. DISTANT

Deaf-Mutes

J'APPRENDS seulement aujourd'hui par M. Graham Bell que *La Nature* à bien voulu mentionner mes communications à l'Académie des Sciences sur l'accent des sourds muets. Je regrette que les *Comptes Rendus* n'aient pas reproduit mes communications *in extenso* et que M. le Secrétaire perpétuel se soit borné à en faire une analyse incompléte. Je prends donc la liberté de vous adresser ces quelques lignes afin que vos lecteurs sachent au juste la portée de ma communication.

J'ai dit que nous sommes frappés de la ressemblance des visages et quelquefois aussi des mains parce que se sont les seules parties du corps, qui ne soient pas couvertes par les vêtements, mais qu'évidemment la ressemblance s'etend à toutes les parties du corps. J'ajoute même que la ressemblance ne s'arrête pas aux traits extérieurs, on doit la retrouver entre les organes. Pourquoi les organes de la voix feraient-ils seuls exception à la règle générale?

M. le sénateur Robin et M. Milne-Edwards, de l'Institut, à qui on ne saurait refuser la compétence en ces matières, nous disaient qu'il ne comprenaient pas qu'on pût faire des objections sérieuses au fait que j'ai signalé touchant la transmission héréditaire de l'accent; que la voix, avec ses diverses propriétés, hauteur, intensité, timbre, accent, est une manifestation des organes vocaux au même titre que toutes les manifestations dont notre corps est le siége. Rien ne se produit au dehors qui n'ait sa cause ou son siége au dedans; c'est dans la constitution intime de notre corps qu'il faut chercher la raison de tous les phénomènes externes. Ainsi s'expliquent les transmissions par voie d'hérédité, soit des aptitudes comme celles pour les mathématiques, les arts graphiques, etc.; soit des affections maladives comme la goutte, le cancer, la folie, etc.; soit des monstruosités comme les doigts surnuméraires, le bec-de lièvre, etc. Pourquoi dans les ressemblances, les organes vocaux seraient-ils exceptés?

Il faut chercher la ressemblance dans la cellule; sans doute, il n'est pas facile de la saisir, mais nous n'osons pas dire, que c'est chose impossible. Une longue expérience est nécessaire pour arriver à saiser des nuances imperceptibles au grand nombre. Ne sait-on-pas qu'un berger reconnait et distingue chaque mouton de son troupeau, tandis que pour nous tous les moutons sont les mêmes à fort peu près.

Ne serait-il pas possible, d'ailleurs, qu'il y eût moins de nuances d'accent chez les sourds-muets et les entendants-parlants americains que chez les Français du Nord et du Midi, de l'Est et de l'Ouest. La voix de nos chers Alsaciens est teintée de sons germaniques, tandis que celle de nos Provençaux a acquis une sonorité et un timbre particuliers qui lui viennent sans doute du long séjour des Romains dans le Midi. Peut-être nous est-il plus facile de constater ces nuances dans la voix chez les sourds-muets de notre pays.

Voici un nouveau fait très curieux sur lequel j'appelle votre attention.

Nanterre (Seine) FELIX HÉMENT

Caution to Solar Observers

IN the interest of solar observers I send you a caution. A first-class sample of black glass was set with a bit of white paper behind it, and exposed for an instant to the focus of a 7-inch lens. The paper was charred where an eye would be placed. A longer exposure of a few seconds made the glass burst asunder.

J. F. CAMPBELL

Niddry Lodge, Kensington, London, W.

Aurora Borealis

WHAT was, probably, the termination of the aurora seen at Worcester and Dublin on May 14 was observed here, by me, between midnight and 1 a.m. of the morning of the 18th. At that time, and for some time after, I saw along the north-west horizon a strong, green, auroral glow. The evening of the 14th was bitterly cold; the sunset clouds threatened snow, wind, light north-north-east light, cloudy. At dawn, the sky was cloudless and wonderfully clear. The 15th was warm and pleasant.

Glasgow, May 24 S. MAITLAND BAIRD GLENNILL

ON THE MUTUAL RELATIONS OF CARBON AND IRON IN STEEL[1]

IN this paper the author sets himself to prove the following four propositions concerning steel: (1) the carbon of steel is (primarily) in a state of simple absorption in the iron; (2) the hardening of steel is due to a metamorphic change in the condition of the carbon, which then assumes a crystalline form closely analogous to the diameter; (3) the varying temper of steel results from the dissociation of this crystalline carbon, at varying but low temperatures; (4) the real strength of steel does not vary to any material degree with a varying content of carbon—that is, *ceteris paribus*, steel is not increased in tensile strength by an increased percentage of carbon.

With regard to No. 1, the author rejects the idea that carbon in steel can be in chemical combination. The only possible hypothesis would be that it is found as a carbide of iron dissolved in excess of iron; and this no modern author holds. It may be alleged in its support that hydrocarbon gas is evolved on dissolving steel in hydrochloric acid; but the great variation in the results and the fact that more or less carbon is at the same time deposited, forbid us to suppose that we have here a definite chemical decomposition. The Eggerty colour test, again, which was supposed to be founded on the same theory, has been in great measure abandoned on account of its inaccuracy. The

---

[1] Abstract of paper by Mr. George Woodcock, read before the Iron and Steel Institute.

phenomena of the conversion of iron into steel in the cementation process all point to the conclusion that the carbon is simply absorbed, as the varying rate of impregnation with variations of temperature, the gradual change from the outside to the inside, and the large deposition of free carbon from such steel, if dissolved in hydrochloric acid, or chloride of copper, or cold dilute nitric acid.

As to No. 2, the author adopts the theory of Jullien, that the hardening of steel is due to the crystallisation of the so-called combined carbon (really absorbed) in a form resembling the diamond. He observes that cemented steel only becomes hard when heated and quenched, and that the fracture then shows innumerable small crystals, which, under the microscope, present physical features very much like small diamonds. These crystals do not appear in wrought iron, increase in number as the proportion of carbon increases, and as the hardening increases, and are more numerous at the outside of the piece, where the hardness is also less. They are therefore crystallised carbon, in other words, diamond. Estimations of carbon in the different layers of a piece of hardened steel have always shown that the actual proportions, as formed by combustion, are the same throughout, but that, as examined by the colour test, they increase gradually from the outside to the inside. This shows that some change has taken place in the carbon. The author's theory is that at a red heat the molecules of iron are expanded and partially separated; that in this state the absorbed carbon is partially dissociated from the iron, and upon the steel being suddenly quenched, the carbon is not re-absorbed, but takes up a small amount of hydrogen, and is fixed in the state of diamond. It is known that hydrogen is present in the diamond, and also in steel, and it is submitted that it forms the active agent in reducing the carbon from the amorphous to the crystalline form. On analysing this hardened steel, it is supposed that the crystalline carbon goes off in all cases as gas; so that less "combined carbon will remain to be shown by the colour tests or deposited on solution in hydrochloric acid. It must follow from this view that carbon is the acting hardener of steel, and that the idea of other elements, as phosphorus hardening steel is a delusion. In support of this it is observed that phosphorus does not harden wrought iron and that probably the real effect of phosphorus and silicen is to cause dissociation of carbon, thus producing a larger extent of crystallisation and a harder metal. Thus it is found that the higher the proportion of phosphorus, the greater will be the difference between the carbon, as shown by the colour test, and as fixed by analysis. Again, English Bessemer or Siemens steel will require 20 per cent. less carbon to make it work and harden equally well with best Swedish steel; the explanation being that the phosphorus in the former assists the dissociation and crystallisation. To this effect of phosphorus many of the mysterious failures of steel may probably be traced.

With regard to No. 3, the author regards the variations of tempering as due solely to the completeness, or otherwise, of the decomposition of the crystalline carbon in the hardened steel. He observes that carbon and iron have no action on each other at the heat at which tempering is effected; while, even at such temperatures, the abstraction of hydrogen from carbon, in the presence of iron, cannot be deemed impossible. The tempering of steel by simply quenching it in hot water or oil, may thus be explained; the outer layers may be supposed to be hardened at first in the ordinary way, but then, as the interior heat does not pass away so rapidly, it has time to act on the crystalline carbon, and partly to dissociate it again, thus producing something between hardened and unhardened steel—in other words, tempered steel. The crystallised carbon in the hardened steel is supposed to be diffused in a state of molecular disaggregation, and to be less intimately united with the iron than before hardening.

As to No. 4, the startling statement that the ultimate strength of steel is very little dependent on its amount of carbon, is explained to refer to the strength as calculated upon the fractured area, not the original area. It is, therefore, equivalent to saying that the contraction of the fractured area in iron or steel is proportional to the diameter of ultimate strength. The author finds that this is the case, both in the various published tables of tensile strength of steel, and in his own experiments. Hence he holds that the contraction of area should be taken as the proper measure of ductility (as is usual on the Continent), and not the elongation. He looks upon hard steel as a metal of a certain strength, having diffused through its mass a greater or less number of particles of a very hard and rigid substance. Hence, as ductility means the power of contracting in area, and extending in length by molecular flow, the ductility will be less as flow is more difficult; and flow will be more difficult as there are more of the rigid crystals in the mass. The apparent strength per unit of original area is thus increased; but the strength per unit of fractured area is usually diminished, probably because the hard sharp crystals tend to cut the metal between them, and produce a sort of tearing action. For these reasons the use of ductile and mild steel, in structures of every kind, is much to be preferred to that of a brittle material, though of a higher apparent tenacity.

A CHAPTER IN THE HISTORY OF CONIFERÆ

THE ABIETINEÆ

THE most recent classification of the *Abietineæ*, and the one that will probably be chiefly adhered to, at least in England, is published in the "Genera Plantarum" of Bentham and Hooker, 1880. In it *Pinus*, *Cedrus*, *Picea*, *Tsuga*, *Pseudotsuga*, *Abies*, and *Larix*, are recognised as separate genera. The tribe comprises the cedars, larches, firs, pines, and contains some 150 species, and is almost exclusively confined to northern and north temperate regions. The genera are all cone-bearing, and with few exceptions produce winged samaroid seeds. No definite remains are known of earlier age than Jurassic, but with the Wealden and Cretaceous they become plentiful, and already in the Neocomian and Gault the ancestors of several existing genera were completely differentiated.

Pinus, Linn.—The cones in this genus vary from the size of a walnut to a length of 19 inches, or possibly even more. The scales are woody and persistent, and closed until the seeds are ripened, when they gape widely. The seeds are in pairs under each scale, and, with few exceptions, winged. The leaves are acicular, and in some cases very long, and are sheathed in bundles of two, three, or five. Nearly all classifications are mainly founded on the number of leaves that occur in a fasciculus, but this character is rejected in the "Genera Plantarum" as inconstant. Two natural divisions are, however admitted—*Pinaster* and *Strobus*.

The former and larger division is distinguished by the scales being very closely adpressed before shedding the seeds, and by their quadrate, umbonate, or elongate, conical heads. The *Strobus* section is comparatively small, and has elongated, often pointed cones, with hard and rigid, yet scarcely woody, loosely imbricated scales, thicker centrally than at the margins, and terminating in a minute or obsolete umbo. Cones of *P. strobus* and *P. excelsa*, representing this section, may be picked up in most botanical gardens, while the *Pinaster* section comprises all the pines commonly grown in plantations.

Besides the "Genera Plantarum," many excellent accounts of the tribe have recently been published. Among these are Gordon's "Pinetum" (1880), Veitch's "Manual of the Coniferæ" (1881), Dr. Maxwell Masters' "Coniferæ of Japan" (*Linn. Trans.* 1881), and an exquisitely illustrated essay on the "Coniferous Forests of the Sierra Nevada," in *Scribner's Magazine*, also in 1881.

Of the *Pinaster* division seventy-seven fossil species were enumerated by Schimper; none, however, are definitely assigned to the group from deposits older than the Eocene of Aix, and most are from the upper Miocene, and even later deposits. The oldest forms are from Solenhofen, and the Gault of Hainault is said to contain connecting-links between the two sections.

Of the *Strobus* division twenty species are enumerated, the oldest being from the Komeschichten of Greenland; but there are a number of additional species which cannot well be grouped in either section.

In England no cones are known that can be referred to Pinus, as now restricted, from rocks older than the Purbeck, but their number gradually increases until the close of the Tertiaries.

Seven species of pine are known from our British Eocenes. They are enumerated here for the first time :—

P. Prestwichii, sp. nov. mihi	Woolwich and Reading Beds.
P. macrocephalus, (Lind. and Hutton)	
P. ovata, (id.)	
P. Dixoni, Bowerbank	Bracklesham to Bembridge.
P. Bowerbankii, Can.	London Clay to Bracklesham.
P. Plutoni, Baily	Eocene of Antrim.
P. Graingeri, id.	

I am not sure that the two latter may not be identical with species already described abroad, but they seem distinct from the other British species.

It will be remarked that all the English species are from marine or estuarine deposits, and it is a singular fact that no trace whatever of leaves or fruit of the Abietineæ have been found in those plant beds of freshwater origin in England, which have recently yielded such exceedingly rich floras. It is equally strange that all our Eocene cones from the London clay and strata beneath have been imbedded before shedding their seed, while those from the Middle and Upper Eocenes are gaping and seedless. If inference upon such slender ground were permissible, it would seem as if those that were imbedded during the cooler Lower Eocene period had grown near to where they were imbedded, and their leaves may yet be found in our little-known Lower Eocene floras, while those that were imbedded during the hottest Eocene periods had drifted a long way. The well-ascertained absence of pine foliage during the Middle Eocene in England, and the constantly-decayed condition of the cones, are the data upon which this view may be grounded. Farther north, at Antrim, as we should anticipate, the cones seem more perfect.

It appears desirable to test the relative length of time that ripe and unripe pine cones, seeds and foliage will float, especially in sea-water, and the length of time required to reduce them to the decayed condition of the Barton and Bracklesham specimens, and it is to be hoped that some one possessing facilities, will undertake experiments.

It will also be interesting to trace out why cones so frequently fall in a closed unripe condition. A Bournemouth resident writes to me that it takes three years for the cone to come to perfection, and that if it remains on the tree all that time, the scales open wide as it hangs, beginning at the base, and making a plainly audible crackling noise as they separate. This occurs chiefly on sunny summer days. The seeds being liberated, either fall or are picked out by tom-tits.

CEDRUS.—Only four species, or varieties according to some, are known—the Himalayan, Lebanon, Atlas, and Cyprus cedars. The cones are globose and erect on the upper side of the branches. The scales are thin, leathery, and closely pressed together, and persist for some time after the seeds are shed. The cones break up on the trees, and fall piecemeal, the scales falling separately, except near the apex, where they remain together as a rosette. This habit may account for the absence of fossil cedars in the Tertiaries, the older forms from the Greensand of Shanklin and Maidstone having possibly possessed a different habit.

PICEA has twelve to twenty-four species. The leaves are solitary, acicular, and more or less in two rows, while the cones somewhat resemble those of the cedar. They inhabit temperate regions throughout the northern hemisphere, almost to the confines of vegetation. Two Gault forms from Hainault are doubtfully referred to the genus, while fossil species are met with in Iceland and Greenland, the Wetterau, the amber-beds, and a few other Miocene localities.

TSUGA possesses five species. The leaves are not very different to those of Picea, and the cones are like those of Cedrus, but pendent and terminal, persisting for several years, and with scales more loosely imbricated and persistent. They inhabit Japan, the Himalayas, and North America, and have been found fossil in the same beds as Picea. *Pinus Crameri*, Heer, related to Tsuga, is the most widely-spread fossil in the Arctic Cretaceous.

PSEUDOTSUGA has only one species, inhabiting from Mexico to Oregon.

ABIES contains eighteen species. The scales are leathery, loosely imbricated, and fall with the seeds and the leaves, as in Tsuga. It extends over the northern temperate regions of both hemispheres, chiefly in mountainous districts. It is known from the Wealden, and even Jurassic, and from Greenland, Iceland, and in European Miocenes.

LARIX possesses seven to ten species. The cones are small, with leathery persistent scales, and fall in clusters with the dead branches. The leaves are linear, solitary, or in bundles, and deciduous in all but one species. The larch extends over the colder regions of Europe, Asia, and America. But four fossil forms have been noticed—three from the Miocene of Francfort, and one from Austria.

The Abietineæ in the existing state in northern regions of Europe, Asia, and America, outnumber the broad-leaved trees by ten to one, for pine-barrens in North America stretch 300 to 500 miles uninterruptedly, and, in the Old World, form a nearly continuous belt from Scandinavia to the east coast of Asia.

Some grow to gigantic size. Sections from two American species of Abies, two of Picea, and one of Pinus, have been exhibited, and officially stated to have been cut from trees considerably over 300 feet in height. In the Himalayas, the cedar and *Pinus excelsa* exceed 200 feet, and other species almost rival these, and even in Europe the heights of several species have been stated at from 120 to 180 feet. The greatest longevity ascribed to any of the Abietineæ belongs to the cedars, which have been estimated at from 600 to 900 years old.

Many of the species are exceptionally hardy, and pass the Arctic circle, and the larch in Siberia extends, as a trailing shrub, to latitude 52°. In Mexico, pines grow at an elevation of nearly 13,000 feet, and in Central Asia, of 10,000 feet.

The economic value of the Abietineæ surpasses that of all other forest-trees, and they supply a very large proportion of the timber in use. Their wood is valuable for all purposes, and some of it is of immense durability, while the money value of that imported into England alone is 9,000,000*l*. per annum, exclusive of other products, such as pitch and tar, which reach nearly another million. The nuts of some species of pine are used as food, and the bark, woody fibre, and secretions are more or less utilised in different countries, and for most varied purposes. Only one species of the whole family is indigenous to England, *Pinus Sylvestris*, the common Scotch pine. the larch and the spruce having been introduced, though both were, I believe, indigenous here in the Pliocene age.

J. STARKIE GARDNER

THE BRUSSELS CHRONOGRAPH

ON November 18, 1880, a description was given in NATURE of certain great galvanic chronographs which were then being constructed by Messrs. E. Dent and Co., of the Strand and Royal Exchange, London. The second of these instruments—that for the Royal Observatory of Brussels—has now been completed. The arrangements for pricking upon the chronograph barrel are much improved, and as they overcome a serious constructive difficulty, we propose to give some account of them.

It will be remembered that the main feature in the chronographs referred to was a cylinder (or barrel) 12 in. in diameter, and 2 ft. 6 in. long. That cylinder, which was covered with paper, rotated once in two minutes Beneath it (see Fig. 1) was a pricker placed in electrical connection with the standard clock, and alongside another pricker placed in electrical communication with an observer at any of the instruments. At every second of the standard clock, the clock pricker rose and punctured the paper. Meanwhile, as the cylinder rotated, the carriage, K, on which the prickers were mounted slowly, travelled along the length of the cylinder; and this motion of K, combined with the rotation of the cylinder, caused the succession of clock pricks to arrange themselves around the cylinder in the form of a spiral. The time of any observation was reckoned by comparing the puncture of the observation pricker with the two adjacent clock pricks. The distance between each successive turn of the spiral of clock pricks was $\frac{3}{20}$ inches, and it was within this space (which was limited by the consideration of the size of the cylinder, and the number of hours of observation it should contain) that the two prickers worked.

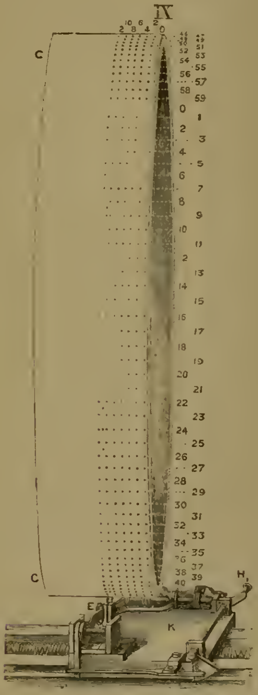


FIG. 1.

In the Brussels chronograph, by the directions of M. Houzeau, the Belgian Astronomer-Royal, provision had to be made for *three* observation prickers, in addition to the clock-pricker. The space available for the prickers to work in was only ⅛ in, and it was obviously impossible to place them side by side. The difficulty was surmounted by arranging them in the form of a fan, so that they should converge into the space, which then became amply sufficient for the disposition of the punctures.

N_1, N_2, N_3, N_4 (see Fig. 2), are the prickers. As may be seen, they take the form of pins with very large heads. Each is mounted in a sheath, S S. Each sheath is jointed (see side section), and swings about an axis A A. It is kept to its bearing by a spring. This arrangement allows the pricker to swing forward a little as it enters the moving paper. It corresponds to the action of the old form of pricker shown in Fig. 3. The pricker, however, that we are describing has an important advantage.

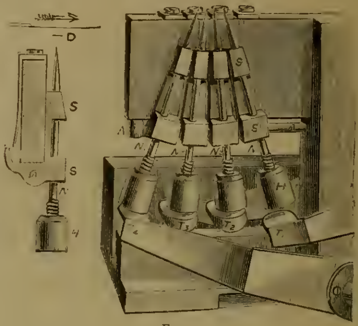


FIG. 2.

It might happen that an observer on pressing down the electric button which worked the pricker, would keep his finger on it. In that case, with the old form, the pricker would be kept against the paper, and would very likely cause damage. But in the new case nothing of the kind would happen, for each pricker, N_1, N_2, N_3, N_4, is *projected* by the blow of its corresponding striker, T_1, T_2, T_3, T_4, and travelling beyond the reach of the striker, pierces the paper by its own momentum only. On falling back, should the striker, T, be still kept raised, the pricker will rest upon it, but its point will be free of the cylinder, and at some distance, D, below it. The strikers, T_1, &c., are worked by electro-magnets: the spiral spring shown just above the head of each pricker, is compressed when the pricker is projected between the head and sheath, and assists in the disengagement of the pricker from the paper. The punctures of the prickers are very marked and distinct.

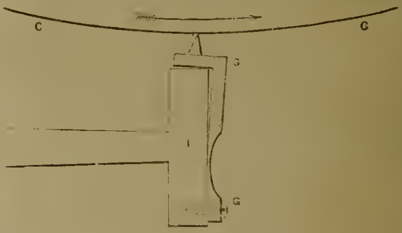


FIG. 3.

A NON-ELECTRIC INCANDESCENT LAMP

A BRIGHT light, easily obtained and sufficient for projections, has frequently been regarded as a *desideratum*, where it has been impracticable to procure either the electric or the lime-light. The French Minister of Public Instruction lately appointed a special commission to indicate the apparatus most suitable for projection in primary schools; and it appeared that while there was no lack of simple arrangements for the projection proper, the problem of easy production of an adequate luminous source was hardly solved.

Dr. Regnard has lately conceived the idea of getting a bright light by burning on platinum gauze a mixture of air and petroleum vapour. The intense heat which results raises the platinum to bright incandescence, giving a light equal to about half the lime-light.

The apparatus (described in *La Nature*, to which we are indebted for the accompanying figure) is very simple. There is an ordinary Bunsen burner, terminated by a small cage of platinum wire. The mixture of air and petroleum vapour is admitted below, in place of the gas; it is produced by a familiar method, and the current is generated by means of a pair of bellows or a Richardson "pear." With a ventilator or "trompe," several of the lamps may be maintained in action at once, for lighting halls, workshops, &c., where there is no gas. The aspect is that of electric incandescent lamps. In this case, it is well to augment the volume of the carbonator, so that the supply of petroleum vapour is abundant. To send all the light in one direction, the Bunsen burner may be fitted with a bent trumpet-shaped nozzle closed with platinum gauze. One has merely to regulate, with the ring of the burner, the admission of the mixture of air and vapour, to have, whenever the current is produced, an extremely bright light.

Regnard's Incandescent Lamp.

With a large loaded bag of air under the table the lamp may be kept in action for several hours, without requiring attention.

The apparatus should be useful to medical men in examination of the larynx, ear, &c.

The expenditure is very small, only a few centimes an hour, with maximum action.

OBSERVATIONS OF THE SOLAR ECLIPSE OF 1882, *MAY* 16, *MADE AT THE RADCLIFFE OBSERVATORY, OXFORD*

THE weather was very favourable, the sky being quite clear.

Ref.	Phenomenon.	Observer.	Greenwich mean solar time.	Instrument.	Aperture.	Clock or chronometer used.	Power used.
			h. m. s.		inches.		
(*a*)	Beginning of eclipse.	Mr. Wickham.	18 12 53·1	Heliometer.	7½	Clock, Dent, 952.	140
(*b*)	" "	Mr. F. Bellamy.	18 12 59·6	Dollond.	3½	Chron., Birch.	80
	" "	Rev. S. J. Perry.	18 12 58·8	Cooke, No. 1.	6	" { Black and Murray, No. 609. }	60
	" "	Mr. Luff.	18 12 52·6	—	2¾	" Pocket Solar.	60
(*g*)	{ Disappearance of a Lunar Mountain. }	Mr. Stone.	19 7 2·2	Cooke, No. 2.	6	" { Frods. and Baker, No. 6149. }	120
	{ Disappearance of a Lunar Mountain. }	Rev. S. J. Perry.	19 7 1·9	Cooke, No. 1.	6	" { Black and Murray, No. 609. }	120
(*c*)	Ending of Eclipse.	Mr. Wickham.	19 21 55·5	Heliometer.	7½	Clock, Dent, 952.	140
(*d*)	" "	Mr. Robinson.	19 21 56·8	Cooke, No. 3.	6	Chron., Dent, 2188.	150
(*e*)	" "	Mr. F. Bellamy.	19 21 51·3	Dollond.	3½	" Birch.	80
(*f*)	" "	Rev. S. J. Perry.	19 21 47·4	Cooke, No. 1.	6	" { Black and Murray, No. 609. }	60
	" "	Mr. Luff.	19 21 52·4	—	2¾	" Pocket Solar.	60

Remarks.—(*a*) The first contact was detected as the merest trace of an indentation on the sun's limb, and the time recorded is considered precise. (*b*) Limbs very steady; the time noted may be a very little late. (*c*) The recorded time of last contact considered accurate, as the moon's limb was followed steadily till the last. The tremor of the sun's limb did not very materially affect the definition. (*d*) Just before contact limbs slightly tremulous; observation considered fairly good. (*e*) Observation good. (*f*) If anything a fraction of a second too soon.

(*g*) This mountain was the highest peak of a ridge of mountains which were conspicuous on the moon's limb.

E. J. STONE

CHEMICAL LECTURE EXPERIMENTS

SEVERAL interesting and instructive experiments have been described of late in the chemical journals: we propose to give a short account of the more important.

I.—PHYSICO-CHEMICAL EXPERIMENTS

A. *Mixing of Gases by Diffusion.*—That gases do not mix very rapidly by diffusion alone, may be illustrated by placing a strip of white paper moistened with lead acetate solution inside a tall glass stoppered cylinder, so that when the cylinder is inverted the paper extends from the bottom (which now forms the uppermost end) not more than one-third of the total length of the cylinder. A little sulphuretted hydrogen water is placed in the hollow stopper of the cylinder, and the stopper is inserted loosely into its place. After ten to fifteen minutes the production of brown lead sulphide on the white paper shows that the sulphuretted hydrogen gas has risen two-thirds of the height of the cylinder. Paper moistened with starch and potassium iodide, and chlorine water, may respectively replace the lead acetate paper and the sulphuretted hydrogen water (C. von Than, *Berichte*, xii. 1414).

B. *Liquefaction of Gases by Increasing Pressure or Lowering Temperature.*—Ethylic chloride, which boils at 12°, is easily liquefied. A Hofmann's lecture eudiometer, with one limb about 100 cm. and the other 50 cm. in length, serves as apparatus. The eudiometer is filled with mercury; ethylic chloride gas is led into the shorter limb through the upper stopcock, while the mercury flows out by the other stopcock; when the smaller limb is partly filled with gas, the mercury is adjusted to the same level in both limbs, the gas is liquefied by pouring ether over the shorter limb, and any air which has entered with the gas is allowed to escape by opening the upper stopcock for a moment. The liquid ethylic chloride is gasified by running out as much as possible of the mercury in the larger limb, and so reducing the pressure. If the temperature is lowered—by pouring ether on to the outside of the shorter limb—or if the pressure is increased—by pouring mercury into the longer limb, equal to an extra half atmosphere of pressure—the ethylic chloride becomes liquid (Hofmann, *Berichte*, xii. 1124).

C. *Absorption of Heat Accompanying Change from Liquid to Gaseous Form.*—A test tube, partly filled with water, is placed in a small glass cylinder containing ether sufficient to completely cover that part of the tube in which there is water. A brisk stream of dry air is driven through the ether, which rapidly evaporates; in a few minutes the water in the tube is completely frozen (Hofmann, *Berichte*, xii. 1125).

D. *Thermal Changes Attending Solution of Salts in Water.*—A small flask of about 100 cc. capacity is fitted with a cork carrying a glass tube, 3-4 mm. diameter, bent twice at right angles; the larger limb of the tube is about 70 cm. in length, and passes through a cork nearly to the bottom of a wide-mouthed bottle, of about 40 cc. capacity, containing coloured water. A straight piece of similar tubing of about the same length passes through a second hole in the cork, and also reaches nearly to the bottom of the wide-mouthed bottle. The salt under examination is placed in the flask, water is added, and the cork is inserted. If heat is evolved during solution, the coloured water rises in the straight glass tube, which is open at the upper end; if heat is absorbed during solution, the water rises in the tube connected with the small flask (Rosenfeld, *Berichte*, xiii. 1475).

II.—EXPERIMENTS ILLUSTRATIVE OF CHEMICAL ACTION IN GENERAL

A. *Conservation of Mass.*—Two small glass tubes, about 15 cm. long by 2 cm. wide, are sealed and rounded off at one end and drawn out at the other to tubes about 3 mm. diameter. About two centigrams of freshly heated charcoal is dropped into one tube, the air is replaced by dry oxygen, which is led in by a capillary tube passing through the narrow opening, and the tube is sealed. The other tube is also sealed at a point such that the weights of the two tubes are equal. The tubes are placed on the opposite pans of a balance, and the balance is shown to be in equilibrium: that tube which contains charcoal is heated by a small gas-flame, the charcoal burns brilliantly, and by carefully shaking the tube is all, or almost all, consumed. When the tube is cold it is replaced on the balance pan, on releasing the beam it is found that no change has occurred in the mass of matter in the tube, although the form of the matter has undergone most marked change. Sulphur, or a very small quantity of gun-cotton, may be employed in place of charcoal in this experiment (C. von Than, *Berichte*, xii. 1413).

B. *The Individual Substances taking part in a Chemical Change Gain or Lose Weight.*—To demonstrate that a substance increases in weight during oxidation, &c., or loses weight during reduction, &c., a piece of copper-wire, about 10 cm. long by 1 mm. thick, is fused into the upper end of a glass hydrometer: the wire carries a little glass cup (the bottom part of a test tube serves admirably) on its upper end, on which lies a piece of platinum foil. The hydrometer is placed in water contained in a cylinder. Such a quantity of finely divided iron as suffices to sink the hydrometer, so that the wire is just wetted, is placed on the platinum foil; the foil is removed, heated till the iron is oxidised, allowed to cool, and replaced on its support: the hydrometer sinks considerably in the water. To illustrate loss of weight on reduction, a little cylinder of copper oxide, made by mixing the substance with gum and drying, may be employed. Before the reduction is commenced, nearly the whole of the wire supporting the platinum foil ought to be immersed in the water (Rosenfeld, *Berichte*, xiv. 2102).

C. *Influence of Mass, Time, etc., on a Chemical Change.*—The influence of *time*, *temperature*, and *mass*, as also the meaning of the phrase *reverse action*, may be qualitatively illustrated as follows:—Three beakers are arranged on white surfaces and with white backgrounds; in beaker (1) is placed about 100 cc. of cold water, in (2) the same quantity of water at 90°–100°, and in (3) about 500 cc. of cold water. A few drops of a solution of bismuth iodide in concentrated hydriodic acid is poured into each beaker; brown bismuth iodide is precipitated in the first beaker, red bismuth oxyiodide in the second, and the same salt, but in smaller quantity, in the third. On standing for a little time, the brown iodide is slowly changed into red oxyiodide; but on adding a little concentrated hydriodic acid, the reverse change—viz. from oxyiodide to iodide—takes place (Muir, *Chem. Soc. Journ. Trans.*, 1882, 6).

The influence of mass and time on a chemical change may be quantitatively exhibited by arranging a series of similar glass cylinders filled with water, and inverted in glass basins: a stoppered retort of about 100 cc. capacity is supported close to each cylinder. The retorts are carefully cleaned, and 50 cc. of pure sulphuric acid, regularly diminishing in concentration by a fixed amount, is placed in each. Sheet zinc is cut into squares of equal sizes, which are rolled into slit cylinders (by bending round a glass rod), cleansed in soda solution, then washed, immersed in strong sulphuric acid, again rapidly washed in a stream of water, and dropped into the retorts, which are then stoppered. The hydrogen which is evolved is collected as long as the areas of the zinc remain visibly constant. The upper surfaces of the water in the cylinders exhibit, in the form of a curve, the influence of the mass of sulphuric acid on the change under consideration. As the evolution of hydrogen may be stopped at any moment by withdrawing the stopper of a retort, the experiment may be arranged to show the influence of time on the change (Mills, *Chem. Soc. Journ. Trans.*, 1880, 454).

III.—EXPERIMENTS ILLUSTRATIVE OF COMBUSTION PHENOMENA

A. *Burning Oxygen in Sulphur Vapour.*—A two-necked balloon is fitted with corks, each carrying a tube, one of which passes towards the bottom of the balloon, and has its tip slightly bent upwards, the other, beginning flush with the inner surface of the cork, passes downwards into a cylinder containing water. The first of these tubes communicates, by means of a long piece of caoutchouc tubing, with a supply of dry oxygen. About 40 to 50 grams of dry sulphur are placed in the balloon, and heated till the vessel is quite filled with reddish vapours, the oxygen delivery tube being meanwhile withdrawn. Oxygen is allowed to flow from the delivery tube in a stream sufficiently rapid to cause a glowing chip of wood held 2 to 3 millims. from the end of the tube to burst into flame; a small piece of charcoal is attached by platinum wire to the tip of the oxygen delivery tube; the charcoal is ignited, and the cork carrying the tube which delivers oxygen is inserted into the neck of the balloon. The oxygen is soon seen burning in the vapour of sulphur which fills the vessel; the product of combustion, viz. sulphur dioxide, is led by the second tube into the water in the cylinder, the presence of sulphurous acid in which is easily exhibited (C. von Tham, *loc. cit.*).

B. *Burning Sulphuretted Hydrogen in Vapour of Nitric Acid.*—60 to 80 c.c. of concentrated nitric acid (sp. gr. 1·53) are placed in a flask of 500 c.c. capacity. A rapid stream of sulphuretted hydrogen is passed, through water, into the acid, whereupon red fumes are copiously produced. The delivery tube is slowly raised from the surface of the acid towards the neck of the flask; at a certain distance from the acid the sulphuretted hydrogen takes fire and burns with a blue flame; the upper part of the flask becomes filled with white fumes of sulpuric acid, the lower part with red fumes of oxides of nitrogen, little or no sulphur separating (Kessel, *Berichte*, xii. 2305).

C. *Burning Ammonia in Oxygen.*—A wide-mouthed flask is fitted with a cork, which carries a tube passing nearly to the bottom of the flask, and also a large straight drying tube, which contains solid caustic soda and is closed at its upper end by a cork carrying a little piece of tubing drawn out to an opening about 2 mm. in diameter. A quantity of strong ammonia liquor is placed in the flask and heated nearly to boiling, the lamp is withdrawn, and the cork with its tube inserted. A stream of oxygen is passed into the hot liquor, and the dry ammonia, mixed with oxygen, is ignited as it issues from the caustic soda tube. As the amount of ammonia diminishes, the flame becomes smaller, but very hot; a piece of platinum wire may be melted, or a lime cylinder may be caused to give out much light, by holding it just above the central zone of the flame (Rosenfeld, *Berichte*, xiv. 2104, and xv. 169.)

D. *To show that Water is produced by Burning Hydrogen in Oxygen.*—A small platinum flask (as is figured in Roscoe and Schorlemmer's "Chemistry," I., p. 339) is furnished with a good cork carrying two tubes of ordinary pipe-clay, which reach towards the bottom of the flask: one of these tubes communicates by caoutchouc tubing with a supply of dry hydrogen, the other with a supply of dry oxygen. The exit-tube of the flask is attached to a piece of glass tubing which connects with a glass worm condenser, underneath which a beaker is placed. Dry hydrogen is passed into the flask until the air is completely replaced from the entire apparatus: while this is being done, the caoutchouc tubing which connects the clay tube with the oxygen supply is securely clamped just above its junction with the clay pipe, to prevent hydrogen from diffusing backwards into the oxygen tubes, and so forming an explosive mixture. When the air is all driven out of the apparatus, the platinum flask is heated to redness, dry oxygen is passed into it, and the lamp is withdrawn. By properly regulating the streams of oxygen and hydrogen, so much heat is produced that the flask becomes nearly white hot; water is quickly formed and trickles, and after a little, flows in a continuous stream through the glass worm into [the beaker beneath (Hofmann, *Berichte*, xii. 1122).

E. *Unburning of Water-gas by Iron and by Magnesium.*—3-4 grams very finely divided iron (*Ferrum alcoholisatum*) are placed in a small piece of hard glass tubing about 12 cm. long and 14 mm. diameter. One end of this tube is connected with a flask containing hot water, the other with an ordinary gas exit-tube and small pneumatic trough. The iron is heated, the water brought to, and just maintained at the boiling-point, and the end of the delivery-tube is plunged under the water in the trough. Hydrogen is obtained in a rapid stream. As thus arranged the decomposition of water-gas by iron is readily shown without the use of a furnace or porcelain tube.

A similar apparatus serves to show the decomposition of water-gas by magnesium; a piece of magnesium-ribbon about 60 cm. long is folded on itself so as to form a bundle about 1 cm. in length, which is placed in the glass tube; the water is kept nearly boiling; the magnesium is heated until it begins to melt and burn at the edges, at this moment the water is rapidly boiled (and the exit-tube is plunged under the water in the trough), when the magnesium is found to burn vividly in the steam and hydrogen to be evolved in quantity (Rosenfeld, *Berichte*, 15, 160.

M. M. P. M.

NOTES

WE are glad to learn that one of the evening (Friday, August 25) discourses at the Southampton meeting of the British Association will be given by Sir William Thomson, and that the subject will be "Tides." Prof. Moseley's discourse on "Pelagic Life" will be given on Monday evening, August 28.

THE honour of Companion of the Order of St. Michael and St. George has been conferred upon Mr. W. T. Thiselton Dyer, F.R.S., Assistant Director of the Royal Botanical Gardens, Kew, for services rendered to Colonial Governments.

THE FRENCH Minister of Public Instruction has again appointed a Commission to direct the deep sea exploration of the Atlantic in the *Travailleur* in July and August next; the investigation will include the ocean bed along the coasts of Spain, Portugal, and Morocco. The members of the Commission are MM. A. Milne-Edwards, L. Vaillant, E. Perrier, Marion, Folin, and P. Fischer.

A FLORENCE correspondent writes:—"On Sunday, May 21, the students and professors of the Faculties of Science and Medicine of Florence assembled to celebrate the memory of Charles Darwin. The large aula of the "Istituto" was crowded with auditors, and many had to be content with standing-room in the corridor outside. An address was read by the representative of the students, and an eloquent study of the genius and character of the great man of science by Prof. Mantegazza. I was struck by the note of religious solemnity that marked the proceedings." Similar testimonies of the high veneration in which the name of Darwin is held abroad come to us from other parts of Italy, as well as France, Germany, Norway, and Russia.

WE lately noticed the death of Mr. T. Donovan, lecturer on physiology and other scientific subjects at the Working Men's College and at the Birkbeck Institution. We learn that he has left a widow and two children, whose position has excited the sympathy of some of those who know the value of the work he did, and that a committee has been formed to collect a fund for their assistance. Mr. R. B. Litchfield, Bursar of the Working Men's College, whose address is 4, Bryanston Street, Portman Square, W., is Treasurer of the Fund.

MESSRS. HACHETTE AND CO. have just published two "map-size" chromo-lithographic plates of the "Phylloxera de la Vigne," one of which illustrates the habits of the insect, whereas the other represents it in its varied stages and conditions. They are especially suitable for the lecture-room, and their distribution in some of our colonies might serve to nip unnecessary panic in the bud. All the figures are enormously enlarged, and highly (perhaps a little *too* highly) coloured, with full explanatory text.

MISS ORMEROD'S "Reports of Observations on Injurious Insects during the year 1881" (W. Swan Sonnenschein and Co.) is far more bulky than its predecessors. This is mainly due to a lengthy and valuable series of reports on the Turnip Fly, which we commend to the notice of all who are likely to be directly influenced by this pest. Other old friends (?) receive their usual share of attention. Miss Ormerod was recently appointed honorary consulting entomologist to the Royal Agricultural Society.

THE following is the programme of the Davis Lectures on zoological subjects which will be given in the lecture-room in the Zoological Society's Gardens, in the Regent's Park, on Thursdays at 5 p.m., commencing June 8:—June 8, Armadillos, living and extinct, by Prof. Flower, LL.D., F.R.S.; June 15, the British Lion, by Prof. Boyd Dawkins, F.R.S.; June 22, Crocodiles, by Prof. Parker, F.R.S.; June 29, British Snakes and Lizards, by Prof. Mivart, F.R.S.; July 6, Frogs and Toads, by W. A. Forbes, B.A.; July 13, Insects and their Metamorphoses, by Prof. Martin Duncan, F.R.S.; July 20, Foreign Zoological Gardens, by P. L. Sclater, M.A., F.R.S.

WE are glad to notice that the Principal of the Royal Agricultural College at Cirencester has supplemented the teaching of biology in that institution, by establishing a thoroughly equipped and efficient biological laboratory. One of the largest and best lighted rooms in the college has been devoted to this purpose, and under the direction of Prof. Harker, has been furnished with dissecting tables and apparatus suited to modern requirements for the effective teaching of the subject. A number of microscopes have been provided; and practical demonstrations in the laboratory now form a necessary part of the course. The students are afforded every opportunity of acquainting themselves with the methods of microscopic manipulation. A special collection of types and a reference library in biology are to form part of the new institution. In view of the growing importance of biology in relation to agriculture, we think this is a wise step in the interests of the student.

ACCORDING to the *Golos* correspondent at Singapore, M. Miklukho Maclay was at that place on April 10, on his return from Australia and on his way home. But his visit home is to be short, as he expects soon to return to Australia, where he has left his large collections. His health is very bad in consequence of continuous fever and neuralgia, and notwithstanding his being only thirty-seven years old, he looks an old man. His twelve years' travel, accompanied with all possible privations, has broken his health. It is to be feared therefore that the publication of the results of his journeys and the description of his extensive collection will be considerably delayed.

IN the Scandinavian Exhibition now being held at South Kensington, there is a very fine and complete collection of objects in prehistoric archæology.

WE have received the second part of the "Descriptions of new Indian Insects from the Collections of the late Mr. W. S. Atkinson," by Mr. Frederic Moore (published by the Asiatic Society of Bengal). The remarks that have already appeared in NATURE, concerning the first part, apply equally to this, and we defer a longer notice until the completion of the work.

"HUMAN MORPHOLOGY" is the title of a work in three volumes, by Mr. H. A. Reeves of the London Hospital, the first volume of which Messrs. Smith, Elder, and Co. will immediately publish.

THE Göttingen Royal Society of Sciences have announced the following subject for prize competition (Beneke-foundation): Comprehensive researches are desired on the microscopical, that is, the anatomical and micro-chemical structure of vegetable protoplasm. The two prizes offered are about 85*l*. and 34*l*. respectively. Papers, written in German, Latin, French, or English, to be sent in in the usual way, before August 31, 1884. The prize award takes place on March 11, 1885.

THE Ben Nevis and Fort-William meteorological observations will be recommenced to-day by Mr. Clement L. Wragge, under the auspices of the Scottish Meteorological Society. A new fixed station is to be established near the lake, about 1,840 feet above the sea, the observations made at which, together with additional observations by means of travelling instruments at certain fixed hours and places to be taken during the ascent and descent, will the better enable atmospheric disturbances existing in the stratum of air between the summit of Ben Nevis and Fort-William to be observed, and discussed with some fulness. The hours of observation at Fort-William will be 5 a.m., 6 a.m., 7 a.m., 8 a.m., 8.30 a.m., 9 a.m., 9.30 a.m., 10 a.m., 10.30 a.m., 11 a.m., 11.30 a.m., noon, 1 p.m., 2 p.m., 3 p.m., 6 p.m., and 9 p.m. The observations to be taken on the journey to Ben Nevis will be 6 a.m. on the peat moss, 7 a.m. at the lake, 8 a.m. about 300 feet, and 8.30 a.m. at Buchan's Well. On the summit of Ben Nevis, Mr. Wragge will observe at 9 a.m. 9.30 a.m., 10 a.m., 10.30 a.m., and 11 a.m. During the descent, or homeward journey, the observations will be at Buchan's Well at 11.30 a.m., about 300 feet at noon, at the lake at 1 p.m., and on the peat moss at 2 p.m. Thus all these observations will be simultaneous with those taken at the low level station at Fort-William. Specially constructed thermometers to record the temperature by clockwork on the top of Ben Nevis at 9 p.m. have been most kindly placed at Mr. Wragge's disposal by Messrs. Negretti and Zambra, London. The indications of these instruments at that hour on the Ben will be of especial value to meteorologists, since the means of temperature and humidity at 9 a.m. and 9 p.m., the observing hours adopted by the English and Scottish Meteorological Societies, will thus be obtained for the top of the Ben. Mr. John Browning, of the Strand, London, has kindly presented a rain band spectroscope, to be used in the Ben Nevis investigations, from the use of which, in the hands of Mr. Wragge, valuable observations bearing on weather forecasting may be expected. Dr. R. Angus Smith, F.R.S., Manchester, has generously undertaken to supply apparatus for measurement of the actinism of the sun's rays and of daylight; and it has further been arranged that a very complete system of ozone observations at the foot, on the slopes and top of the Ben shall be carried out. The ordinary observations on Ben Nevis, at Fort-William, and at intermediate points will be of atmospheric pressure, temperature of the air, earth, lochs, and wells, direction and force of wind, kind, and amount of cloud, movements of the various strata of cloud, rainfall, ozone, and optical phemena. Additional rain gauges will be fixed on the summit of Ben Nevis to ascertain if the rainfall is the same with various winds at different points of the plateau, particularly from near the edge of the tremendous cliffs inward over the plateau. The work of arranging and opening the stations has already been commenced, and Mr. Wragge will doubtless have the entire system in full working order by 9 a.m., June 1, as stated above.

WE learn from *Naturen* that the authorities at Washington have availed themselves of the presence in the capital of Herr L. Stejneger, of Christiania, to secure the services of this eminent

Norwegian naturalist to conduct a scientific mission to Kamchatka. At two days' notice, Herr Stejneger started, on March 22, well supplied by the U.S. Signal Service Department with all the instruments and appliances necessary for carrying out his instructions which emanate conjointly from the Smithsonian and the U.S. Meteorological Institutions. A year and a half has been suggested as the term of his mission, but in this, as in other matters, he is left to follow his own judgment in regard to the best way of attaining the objects it is proposed to secure. These are: (1) the erection of a meteorological station, of the first class if possible, on the coast of Kamchatka, and one of the second or third class on Behring Island, and at Petropawlovsk, for each of which he is to make arrangements that will secure their permanent efficiency after his departure; (2) in the capacity of a member of the U.S. Fish Commission, to draw up a report of the fishing-grounds, more especially with reference to the condition of the cod-fisheries; (3) to collect, for the national museum the largest attainable number of the remains of the now extinct Rhytina, or Arctic sea-cow, good skins of *Phoca leonina*, *Otaria ursina*, and other sea-animals, together with a few skeletons and a large number of the crania of these and other marine mammals, and of the local birds and fishes. Herr Stejneger promises to keep the readers of *Naturen* acquainted with the success that may attend him in the prosecution of his various and arduous labours.

WE are glad to observe that the telegraph is making rapid way in China. The Shanghai-Tientsin line has been working now for a few months, and a line is being constructed in the south between Canton and Hongkong—a distance of about 100 miles. The first section is to connect Canton, which is practically the commercial capital of China, with the frontier of British Kowloon, situated opposite the town of Victoria. After some consideration it has been decided that a land-line is preferable to a submarine cable, as it will be more economical, and the latter also would seriously interfere with the enormous junk traffic and fishing operations in the estuary of the Canton River. It is interesting to remark that this line is purely a private undertaking of a company of Chinese merchants in Canton, who, doubtless, want to be on a level with their brethren in the north, in rapidity of communication with the markets of the world. The line, as above stated, will for the the present terminate on the confines of British territory. It seems hardly credible—but the fact is stated in the Hongkong journals—that opposition is made by the British authorities to the further construction of the line, and especially to the cable across the harbour necessary to connect Kowloon with Hongkong, unless it is constructed by a British company.

WE regret to see that the project of a meteorological observatory in Hongkong, which we have already described in NATURE, is still "under consideration." Major Palmer's very complete scheme, on which we commented at the time, was in the hands of the Colonial Office six months ago, but nothing has since been done, and there seems to be grounds for the fear that a work of much importance, local as well as general, for which funds are amply provided by the colonial authorities, will be postponed so long that the officer to whose knowledge and ability the scheme is chiefly due will have left the colony. It will be difficult and may be impossible to find a well-qualified substitute in a small community such as that of Hongkong.

THE Aëronautical Society of Great Britain propose to hold next year an exhibition similar to the one held in the year 1868 at the Crystal Palace, with the object of ascertaining the position of the science of aëronautics, and with the view of affording an opportunity to inventors to embody and exhibit the results of their labours. Several prizes will be offered, and an exhibit of balloons and all the appliances connected therewith will be invited; also of any methods for propelling a balloon or any gas vessel, influencing its direction, prolonging its life, improving its utility, &c. The Council will be glad to have an intimation addressed to the secretary, from members or others, that they are likely to exhibit, or to assist in raising the funds which will be necessary to carry out the project.

IT has been decided by the Chancellor of the Upsala University to purchase the botanical collection belonging to the famous Swedish botanist, the late Prof. Elias Fries, for a sum of 1250*l.*; the collection, however, does not include a Scandinavian Phanerogam herbarium, a collection of mosses and algæ, as well as some other objects, which have been purchased by some one, who desires to be unknown, and presented to the Botanical Museum in Upsala.

THE Swedish Diet has voted a sum of about 300*l.* towards a geological expedition to Spitzbergen in the summer of 1883, which amount will be placed at the disposal of the Academy of Science in Stockholm; it is, however, stipulated that all objects collected shall be presented to the National Museum.

INTELLIGENCE from the island of Fayal, one of the Azores, states that a violent earthquake occurred there on May 3. The shocks continued during an hour, in which time churches, public buildings, and several houses were destroyed.

AFTER efforts to domesticate several species of wild ducks in America, capturing them young, or raising them from the eggs, Mr. Lindon says (Buffalo Soc. Nat. Sci.) that none adapted themselves thoroughly to the barnyard state except the mallard, dusky duck, and Canada goose, whose progeny prospered well, and attained a greater weight and size than the ordinary domesticated stock. Some of them betrays a tendency to revert in plumage, to their original condition, but the majority have been completely metamorphosed into the ordinary barnyard fowl. No hybrids from any two different wild species, which bred only within the inclosure, were ever obtained, except from crosses between the mallard and dusky duck. The mallard has been supposed to be the originator of the common tamed ducks, but the dusky duck is now pronounced to be fully as domesticable.

IN view of the vagueness of expression "rainy day" in meteorology, Prof. Schmeltz has lately devised an apparatus to register the actual duration of rain. (He was not aware of M. Redier's apparatus for this purpose). From a description in the *Journal de Physique* (May), we learn that a long band of Morse paper sensitised for rain is used. The paper is dipped in a solution of sulphate of iron, dried carefully, and coated with tannic acid, or pulverised ferrocyanide of potassium, mixed with powdered resin for better adherence. The strip is stretched between rollers, one of which is actuated by means of an endless chain from a toothed wheel on the axle of the minute hand of a common clock. It passes under a funnel in the top of a wooden case, which is open below and is fixed outside a window. By means of guide rollers it receives double inclination (longitudinal and transverse), and the rain in excess does not sensibly spread beyond the part passing under the funnel. The length which the rollers transfer during a whole day is divided into twenty-four equal parts, each corresponding, on an average, to an hour. When no rain has fallen during the day, the paper strip used may be utilised again, being easily wound on the delivering roller. This simple and cheap apparatus is said to act admirably.

A WELL-ARRANGED and instructive Popular Handbook to the Natural History Collection in the Museum of the Yorkshire Philosophical Society, has been issued by the keeper, Mr. Walter Keeping.

THE Council of the Society of Telegraph Engineers and of Electricians have determined that the Society shall offer three premiums annually for the best original papers sent in to the Society on Telegraphic or Electrical Subjects during the Session by any person not being a m.mber of the Council of the Society. The 1st Premium will be called the Society's Premium, value 10*l.*; 2nd, the Paris Electrical Exhibition Premium, value 5*l.*; 3rd, the Fahie Premium, value 5*l.* The Premiums will consist of books or scientific apparatus. The first Premium will be awarded in 1883 for the best papers sent in between this date and the end of May next.

DR. F. A. FOREL, of Morges, informs us that the supposed lacustrine canoe referred to in NATURE, vol. xxvi. p. 67, was really a simple trough made out of a log, for the reception of spring water.

THE additions to the Zoological Society's Gardens during the past week include a Spotted Cavy (*Cœlogenys paca*) from South America, presented by Mr. V. Gibbs; a Red Brocket (*Cariacus rufus* ♂) from Trinidad, presented by Mr. H. Sandbach; a Black-breasted Sparrow (*Passer diffusus* ♂), a White-throated Seed Eater (*Crithaga albogularis*) from South Africa, presented by Mr. J. Abrahams; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Capt. E. C. B. Walker; three Midwife Toads (*Alytes obstetricans*), fourteen Alpine Newts (*Triton alpestris*) from Belgium, presented by M. G. A. Boulenger; a Lesser White-nosed Monkey (*Cercopithecus petaurista* ♀) from West Africa, a Jackass Penguin (*Spheniscus magellanicus*) from the Falkland Islands, two Cape Crowned Cranes (*Balearica chrysopelargus*) from South Africa, a Flamingo (*Phœnicopterus antiquorum*) from North Africa, two Bernicle Geese (*Bernicla leucopsis*), two White-fronted Geese (*Anser albifrons*), a Ruddy Sheldrake (*Tadorna rutila*), a Herring Gull (*Larus argentatus*), European, a Bordeaux Snake (*Coronella girondica*), South European, deposited; a Koala (*Phascolarctos cinereus*) from Australia, two Javan Peafowls (*Pavo spicifer* ♂ ♀) from Java, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE COMET.—The following orbit of the present comet has been calculated by Mr. Hind, from observations at Harvard College, U.S., on March 19, Josephstadt (Vienna) on April 19, and one by Prof. Millosevich, at the Collegio Romano, Rome, on May 21; parallax and aberration were taken into account:—

Perihelion passage, June 10·52442 Greenwich M.T.

	°	′	″	
Longitude of perihelion	53	55	18·0	From M. Eq., 1882·0.
,, ascending node...	204	53	56·9	
Inclination...	73	46	39·8	
Log. of perihelion distance ...	8·782864			

Motion—direct.

From these elements we find the positions near perihelion passage thus—

	d.	h.	R.A. °	R.A. ′	Decl. °	Decl. ′	Distance from Sun's centre. In R.A. ′	″	In Decl. ′	″	Intensity of Light.
June	10	0	74	58·4	+23	41·9	−3	33	+0	40	82·6
	10	6	75	50·8	+22	34·5	−2	56	−0	29	104·5
	10	18	78	0·2	+20	29·2	−1	18	−2	36	105·2
	11	0	79	16·1	+19	40·4	−0	17	−3	26	87·6

The intensity of light on May 21 has been taken as unity. The comet was then judged to have the brightness of a star of 5·6m. On May 18 Mr. G. Knott estimated it a little higher than 6·0, which fairly accords. Whence theory would raise it to over an average first magnitude at perihelion. With due precautions which will occur to most observers who have large refractors, it is now seen to be by no means improbable that the comet may be observed in full daylight, on June 10 and 11. Still it may be well to remark that as compared with the first comet of 1847, observed at noon, close to the sun, on March 30, by Mr. Hind, with a 7-inch refractor, stopped down to about 3 inches, the theoretical intensity of light at perihelion is not quite half as great; thus calling the brightness unity when the comet was first glimpsed with the naked eye, the brightness of the present comet at perihelion will be 186, while that of the comet of 1847 was 408.

By the above orbit the comet traverses the plane of the ecliptic at the ascending node 0·038 within the earth's track.

DOUBLE STARS.—No. 6 of "Publications of the Cincinnati Observatory" has been issued. It contains micrometrical measures of double stars made with the 11-inch refractor in 1879–80, consisting partly of observations preliminary to the formation of a general catalogue of known double stars situated between the equator and 30° south declination, and partly of observations of objects which Mr. Burnham has found to need re-observing. The cases of notable differences from previous measures are collected in the introduction. Mr. Ormond Stone is doing excellent work with his refractor, which appears to have been much improved since the object-glass was re-figured by Messrs. Alvan Clark and Son.

THE VARIABLE STAR U GEMINORUM.—Mr. G. Knott, writing from Cuckfield on May 29, states that he had caught a maximum of this apparently capricious variable on May 27 or 28; on both nights it was about 9·9 m. This, compared with the previous maximum noted by the same observer on February 28, gives a period of eighty-eight days.

Prof. Schönfeld finds that a star R.A. 16h. 13m. 36s., Decl. −7° 21′·0 for 1855 is variable.

A star in R.A. 19h. 17m. 33s., Decl. −21° 32′·3 for 1850, must be variable to a great extent—6·5 to 9·0 at least.

TEMPERATURE REGULATORS

BEFORE proceeding to the consideration of some of the means adopted for controlling temperature, more or less perfectly, it will be as well to notice two instruments, because although they are in reality only indicators, yet the latter is always referred to as a regulator.

Hall's aërometer[1] consists of a glass bulb 4½ c.i. in capacity, attached to a long tube whose capacity is 1 c.i. This tube is inserted into another of nearly equal length, and supported on a stand. The first tube admits of being sustained within the second at any given height by means of a spring. The outer tube is charged with mercury or water, according to circumstances, and the bulb and inner tube are arranged to contain, at the normal pressure and temperature, 5 c.i. of air. Any changes, therefore, in the atmospheric conditions will affect the level in the inner tube, and can be allowed for accordingly.

Doyere's regulator[2] (1848), which is on the same principle, consists of a glass bulb, to the bottom of which a fine tube is attached. This tube is bent, then carried upwards for a certain distance, is then bent again to form an inverted U-tube, the extremity is again bent upwards, and terminates in an open bulb. The lower bulb and the quill-tube are partly filled with water, the surface of which in the tube indicates by its change of position the alterations in the volume of the air contained in the bulb. The principle on which Fresenius' cast-iron drying-disk is constructed is the same which long ago led to the use of sand-baths, for it is obvious that if a large mass must be warmed before the heat can reach the substance, a rapid rise in temperature is impossible. The number of substances which can be conveniently dried at the temperature of boiling water, and the number of chemical operations which require that temperature, have led to the construction of every variety of water-bath and water-oven. With a temperature not much above the boiling point of water, the increase may be obtained by using solutions of various salts; but with these the evils of bumping and crystallisation are so great that Sprengel (1869)[3] replaced the water in a water-oven by sulphuric acid having a specific gravity of 1·55, and for that purpose constructed a leaden one of the following description: The outside case of the double-walled air-bath is a 6½-inch cube, the inside a 5-inch cube. The worm, made of about 30 feet of leaden piping of ⅜-inch diameter, is 15 inches high and 4 inches wide. The coils of the worm are kept apart from each other ⅛ inch by means of solder, and the worm is kept in its upright position by two iron supports soldered to the sides of the air-bath.

Laspeyres[4] (1874), using the same liquid, constructed two pieces of apparatus. One was a glass flask so arranged that

---

[1] *Q. J. Sci.* v 52 (1818) Faraday's manip. 375.

[2] *Ann. Chim. Phys.* [3] xxviii. 5 (1850), Gerhardt 1,105.

[3] *Journ. Chem. Soc.* xxvi. 458 (1873).

[4] *Pogg. Ann.* clii. 132 (1874).

the substance could be heated in a test-tube; and the other consisted of a platinum vessel so constructed that the substance could be inserted into a horizontal tube.

Although Laspeyres in the article just quoted argues most conclusively that an absolutely constant temperature cannot be maintained by controlling the gas-supply, and Jac. Myers concludes his considerations on the subject by saying, "For so long must we give up the hope of being able to regulate these temperatures at pleasure," yet the subject of temperature-regulators is one to which so many have at various times turned their attention, that a comparison of the different methods is not without interest. Most of the instruments constructed may be classified under one or another of the following heads, viz., as modified:—

Air thermometers, with mercury or other fluid arranged to control supply of gas:—(*a*) in which the mercury employed becomes more or less heated while in use; (*b*) in which the mercury or other fluid does not become heated.

Mercurial thermometers (*a*) acting directly on gas-supply; (*b*) acting on gas-supply through the intervention of electric arrangements.

Vapour-tension thermometers.

Air Thermometers (*a*).—Kemp's regulator (1852) consists of a glass tube, at one end of which an elongated bulb is blown; the part of the tube near the bulb is then bent so that the open end of the tube and the bulb are parallel.[1] Sufficient mercury is then introduced to partly fill the bulb, the remainder being occupied by air. To the open end of the tube is cemented a brass cap, which is provided at the side with the gas inlet tube, and in the centre with a stuffing box, through which the brass outlet tube slides. The temperature is adjusted by moving this tube up or down as the case may be.

Bunsen's modification made the apparatus more compact, but not so simple or easy of construction.[2] It consists of a glass cylinder whose lower part is closed, and serves as air-vessel which communicates with the upper portion by a tube reaching nearly to the bottom. In the upper portion is inserted a wide glass tube which is provided with a side-tube, and which dips into the mercury. Fastened to the upper end of this tube is the gas-supply tube, which is rather shorter, and which has a fine opening in it. The position of these tubes is adjusted by the screw-thread in a brass cap, which works on a corresponding thread in the supply tube. The two parts of the apparatus are held together by a spring (in the newer patterns this is replaced by a pin working in a groove).

His low-temperature regulator has a much larger air-chamber, so as to increase its sensitiveness.[3] It is also provided with a side-tube fitted with a stopcock, so that mercury may be added or drawn off at pleasure. Guthrie[4] (1868) constructed a regulator on Kemp's principle, but attached the top of the vertical tube to the bottom of an U-tube which the gas had to traverse, so that the mercury on rising checked the flow. The adjustment consisted of a side tube (bent at a right angle) attached to the vertical tube; in that tube a glass rod could be raised or depressed, being held in its position by passing through a perforated cork. Müncke's[5] (1876) is very similar to Bunsen's, but the brass cap and fittings are entirely dispensed with, as the gas-supply pipe works stiffly through a perforated cork which fits the top of the tube.

Air Thermometers (*b*).—Schorer[6] (1870) used for an air-vessel a test tube 60 mm. × 14 mm., fitted with an india-rubber cork, and connected by a narrow tube with one limb of an U-tube, partly filled with mercury, the other limb being fitted with the control arrangement of Bunsen's pattern.

Clowes[7] (1871) constructed an apparatus on the same principle, but added a small outlet tube at the bottom of the U-tube, so that by means of an india-rubber tube, which is closed by a screw clip, the mercury level in the U-tube may be adjusted. In his apparatus the gas exit consisted of a glass tube passing through a perforated cork.

Jeannel[8] (1872) used a metallic air-vessel of 300-400 c.c. capacity, communicating, as in Schorer's, with an U-tube (charged, however, with glycerine instead of mercury). The pressure of the air in the vessel is regulated by means of an india-rubber ball, which is fitted (by means of a T-piece and stopcock) to the connecting tube. The flow of gas is controlled by means of a float in the other limb of the U-tube, which approaches or recedes from the end of the gas-delivery tube. The float is held steady by a guide needle, which is fixed to the upper extremity by means of sealing-wax. He mentions Steling's regulator, but gives no reference.

Martenson[1] (1872) used an air-chamber 14 c.m. long × 2 c.m. diam., and connected it by means of a fine tube with a modified U-tube charged with mercury. The rough adjustment is made by a fine opening in the narrow tube, which is closed by slipping an india-rubber tube over it, and the final adjustment is made by means of the gas-delivery tube, which works air-tight through a cork. A side branch to the U-tube serves as a by-pass.

J. Myers[2] (1872).—In this apparatus the air-vessel consists of four tubes 15 c.m. long × 2 c.m. diam. connected together by small tubes, and which then communicate with a regulator similar to that which Schlösing uses.

Cresti[3] (1878) employs a glass apparatus consisting of a horizontal air-vessel 15 c.m. long × 2 c.m. diam.; to this is attached at right angles a glass regulator of the Bunsen-Kemp pattern, the communication between the two being made by a capillary tube which enters the upper part of the air-chamber of the regulator. It is however a form of regulator which would require to be well screened from draughts, as so much of it is exposed.

Mercurial Thermometers (*a*).—Carmichael's[4] (1870) arrangement consists of a tube 40 cm. long by 6 mm. diameter, closed at one end, so that when filled with mercury it forms an elongated thermometer. This is bent according to the bath in which it is immersed, but is so arranged that the open end is vertical; near this end is affixed a side tube of 2 mm. diameter. This tube, after bending upwards, bifurcates. Into the open end of the larger tube a cork is fitted, through a hole in which a glass rod slides. This rod serves as a regulator to adjust the level of the mercury in the side tube.

In Hannay's[5] (1874) arrangement the principle is the same as in the preceding, except that the adjustment is effected by means of a piston in the side tube, which is graduated, while the main tube is bifurcated. It is open however to the objection that the gas has to pass over heated mercury.

Schlösing[6] (1870) used a very fine tube of considerable length (suitably bent) as the mercury reservoir, and led the open end of it into one of the horizontal arms of a T-piece. The other horizontal arm carried the inlet-pipe of the gas, which passed to the burner through the vertical arm. The escape of the mercury from the reservoir was prevented by a piece of sheet india-rubber, which was tied over the end of the tube. As the mercury expanded it forced this elastic cap to assume a globular form, and thus checked the supply of gas. The quantity of mercury in the reservoir was adjusted by means of a side-tube provided with a stop-cock (Fig. 4). The outer tube of Fig. 1 is replaced by a four-branched bulb which contains the extremities of the reservoir and of the gas entrance tube; but these are separated by a small wooden disk with a handle attached, which is fixed in the upper branch, and which rests lightly on the india-rubber sheet. The diameter of the gas tube no longer depends on that of the india-rubber; it can be larger, and the opening gaining in circumference can be diminished to become so narrow that the slightest movement of the disk closes it. Total extinction of the flame is prevented by a small radial groove on the disk.

Reichert[7] (1872) constructed his regulator by expanding the top of the thermometer tube so as to form an elongated bulb. In the top of this bulb was fixed the gas-inlet tube, which nearly reached the lower extremity of the bulb. A side tube served as gas exit. The adjustment was effected by means of a screw which worked in a cap cemented on to a side tube in the stem of the thermometer.

Milne-Edwards[8] (1872) describes a regulator similar to Reichert's, but does not specify what shape or description of bulb he employs.

Schäfer's[9] (1874) is essentially the same as the preceding, except that the inlet tube is a small steel tube with slit at lower extremity.

---

[1] Williams, "Chem. Manip.," 49.

[2] Desaga's "Price List." Fig. 614.

[3] Desaga, Fig. 1.078.

[4] *Phil. Mag.* xxxvi. 30 (1868): Strecker's "Jahresb.," 78 (1868).

[5] *Ding. Polyt. Journ.* 219, 72 (1876).

[6] *Fres. Zeit. Anal. Chem.* ix. 213 (1870).

[7] *Journ. Chem. Soc.* xxiv. 639 (1871).

[8] *Ann. Chim. Phys.* [4]. xxv. 386 (1872).

[1] *Pharm. Zeit. f. Russ.* xi. 136 (1872); *Chem. Centr.*, 513 (1872); *Journ. Chem. Soc.* xxvi. 471 (1873).

[2] *Deut. chem. Ges. Ber.* v. 859 (1872); *Chem. News*, January 10, 1873.

[3] *Gazz. Chim. Ital.* viii. 292 (1878); *Journ. Chem. Soc.*, abst., 294 (1879).

[4] *Chem. News.* November 3, 1871.

[5] *Journ. Chem. Soc.* xxvii. 206 (1874).

[6] *Ann. Chim. Phys.* [4] xix. 205 (1870); *Fres. Zeitsch.* ix. 477 (1870).

[7] *Pogg. Ann.* clxiv. 467 (1872); *Fres. Zeitsch.* xi. 34 (1872).

[8] *Ann. Chim Phys.* [4] xxv. 390 (1872).

[9] *Quart. Journ Micro Sci.* 394 (1874).

Page[1] (1876).—The regulating arrangement is the following: A piece of glass tube about seven-sixteenths of an inch diameter and 1½ inch long is fitted at one end with a short round cork; through the centre of this cork a hole is bored, so that the stem of the thermometer just fits in it; the other end of this glass tube is closed by a short tightly-fitting india-rubber cork, which is pierced by a fine brad-awl through its centre. Into the hole thus formed is forced a piece of fine glass tubing three inches long and small enough to fit loosely inside the stem of the thermometer. The gas enters by this fine tube.

Fletcher[2] (1876) stated that he had for some time used a similar regulator, but that the thermometer had an iron bulb capable of containing two or three pounds of mercury. He also reversed the direction of the gas.

Mercurial Thermometers (*b*).—Scheibler[3] (1865) devised the following arrangement. In the bath or chamber which is being heated is placed an electric thermometer; this communicates with an electro-magnet which is inclosed in a small metallic chamber through which the gas for the burner has to pass. When by a rise in temperature the circuit is closed, the hinged armature of the magnet is brought into contact with the opening of the gas inlet-tube, and is not liberated until a fall in the temperature breaks the circuit.

O. Zabel[4] (1867) placed in communication with an electric thermometer a contrivance which consisted of two electro-magnets acting on a hinged metallic screen. The completion of the circuit by a rise in temperature placed the screen over the flame, and thus checked the heat.

J. Maistre[5] (1866) recommended an electric thermometer connected with an electro-magnet, the armature of which could remove the gas-burner from under the bath, or which could be connected by means of a lever with the gas-supply tap.

Springmühl[6] (1871) arranged an electro-magnet with a hinged armature, so that on the completion of the circuit a weight attached to a lever closed the gas-tap, which was not opened until the release of the armature liberated a spring which acted in the opposite direction.

Vapour-tension Thermometers.—Appold's[7] consists of a glass tube having a bulb at each end. The tube is filled, as also about half of each bulb, with mercury; the lower bulb containing ether to the depth of half an inch, which floats on the mercury. The tube is secured to a plate of boxwood, supported on knife-edges, on which it turns freely. At the end of the plate, underneath the higher bulb, is a lever, which controls the supply-valve of a gas-stove or the damper of a furnace. With a rise in the temperature the increased tension of the ether-vapour drives more mercury into the upper bulb; this end then falls. With a diminished temperature the reverse action takes place.

Andreae's[8] (1878) is like Kemp's and various others, on the principle of an U-tube with one limb closed. It is, however, rendered more sensitive by the introduction of a certain quantity of a volatile liquid into the air space. It must be borne in mind that the liquid must be selected according to the temperature required, as it is obvious that the regulator cannot be used in any case where it has to be heated beyond the boiling-point of the liquid.

Benoit[9] (1879) constructed an apparatus in which he regulated the temperature by adjusting the pressure on the volatile liquid contained in the bulb. The following is the arrangement:—A small reservoir, which can be shaped to suit the oven or bath in which it is placed, holds the volatile liquid. This is connected by means of a tube from the bottom, to which is attached an india-rubber tube, to a regulator of the same pattern as that used by Reichert. The regulator is fixed on a board which can be raised or lowered, and is provided with two side tubes for adding or drawing off mercury at will.

By-pass.—Since it is obvious that in cases where the quantity of gas required to pass through the regulator is large, any perceptible increase in the pressure or the supply from the main must be accompanied by a rise in the temperature of the bath, it is advisable therefore to adjust the by-pass tap so that as small a quantity as possible shall have to pass through the regulator. Here, however, experience must decide how wide a margin must be left to the control of the regulator, for in some districts the difference between the day and evening pressures is so great that adjustment becomes a matter of great difficulty. In some laboratories, especially when near a suburban gas-works, the day pressure is so low and the evening pressure is so high that unless a pressure regulator be interposed between the main and the temperature regulator, the by-pass cannot be used.

Bunsen's[1] thermostat is the vessel in which he maintains a constant temperature, and which is used by him in his vapour density method. It consists of a sheet-copper cylinder, from which at seven places equally distant from each other project pairs of copper rods 7-8 mm. thick, which are riveted and brazed into it. These rods are heated by gas flames, and the temperature is adjusted by moving the burners to or from the cylinder; but in order to maintain it as constant as possible, the apparatus must be carefully screened and the heights of the flames kept nearly equal by means of a gas-regulator, and the flames must reach a height sufficient to keep both the copper rods in the middle part of the flame, and not to have the upper rod heated only by the extreme point of the flame.

Hipp's[2] (1868) regulator, which is described by Hirsch (and is therefore sometimes referred to as Hirsch's), consists of a bent compound metallic strap, *steel* on the outside and brass on the *inside*. The ends thus approach with a falling temperature. The one end is fixed securely inside the air-bath, and the free end communicates by means of a fine copper wire with a regulating screw which connects it with a bent rod carrying the gas-control valve.

Flow of Liquid.—Dupré and Page[3] (1869). The water-bath contains a coil of metal-tube like an ordinary condenser. The lower end of this coil is connected with a second and smaller worm, which is contained in a small water-bath. The latter is heated by a lamp and kept gently boiling. The lower end of this second worm is bent upwards and terminates in a long funnel. Any water poured into this funnel will pass first through the worm surrounded by boiling water, and be thus heated, and then through the tube in the water-bath containing the specific-gravity bottle. By regulating the flow of water the temperature of this water-bath can be raised quickly, or kept constant at any desired point.

Stricker and Burdon-Sanderson[4] (1870).—In this apparatus, which is especially arranged for heating the stage of a microscope, the temperature is adjusted by regulating the flow of boiling water, through the hollow stage, by means of a compression clamp. As the water in the small boiler is kept at a constant level by means of an overflow, the supply when once adjusted remains uniform.

The exceedingly accurate method of maintaining a constant temperature by controlling the pressure under which a liquid in an outer casing is made to boil, is one that depends so essentially on pressure that its consideration must be reserved for the paper on Pressure-regulators.

J. T. BROWN

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The establishment of the Waynflete Professorship of Physiology was provided for by the late University Commission, it being arranged that the emoluments of the post should be paid out of the funds of Magdalen College, to which college the Professor is to be attached as a Fellow. Magdalen College had already shown interest in the development of physiology, and has for some years past maintained a physiological laboratory, in which Mr. Yule, Fellow of the College, has given courses of instruction in Practical Physiology, open to all members of the University, and his lectures have been attended by all candidates for honours in physiology, such instruction not having been available elsewhere in Oxford. Since the passing of the new statutes, the Linacre Professorship has become confined to Human and Comparative Anatomy, and there has been no University representative of physiology. The want of a Professor of Physiology has lately been very strongly felt, especially as the number of candidates in the subject has much increased. It is understood that Magdalen College, acting on the representations of the University to that effect, has determined to apply such surplus funds as are avail-

---

[1] *Journ. Chem. Soc.* i. 24 (1876). [2] *Journ. Chem. Soc.* i. 488 (1876).

[3] Carl Repert, "Exp. Phys." iv. 122 (1868); *Fres. Zeit. Anal. Chem.*, vii. 88 (1868).

[4] *Ding. Polyt. Journ.* 186, 202 (1867): *Fres. Zeit. Anal. Chem.* vii. 239.

[5] *Les Mondes*, x. 271 (1866).

[6] *Ding. Polyt. Journ.* ccii. 242 (1871): *Fres. Zeit. Anal. Chem.* xi. 431.

[7] *Proc. Roy. Soc.* xv. 144 (1866). [8] *Ann. Phys. Chem.* iv. 614 (1878).

[9] *Séance de la Soc. Franc. de Phys.*, 6 (1879).

[1] *Liebig's Ann.* cxli. 273 (1867); *Phil. Mag* xxxiv. 1 (1867).

[2] Carl Bepert. "Exp. Phys." iv. 201 (1868); *Dingl. polyt. Journ.* cxci. 366 (1869).

[3] *Phil. Trans.* clix. 608 (1869). [4] *Q. J. Micro. Sci.*, 366 (1870).

able at once to the foundation of the professorship, and it is expected that an election to the post will therefore take place shortly. All praise is due to the college for having thus promptly acted in the best interests of science in the University, and given this professorship precedence amongst several other schemes which might have been carried out by it first instead. The Profesor is required by the Statutes to give instruction in Human and Comparative Physiology, with histology.

CAMBRIDGE.—The annual report of the Museums and Lecture Rooms Syndicate at Cambridge has contained in past years no more valuable record of work than that lately issued. Taking first the department of experimental physics, we learn that sixty-two students were attending the practical classes in the Lent term, doing work which few of the candidates for the mathematical or natural sciences triposes ever did at Cambridge before the establishment of the Cavendish Laboratory. The pupils in mechanism in Prof. Stuart's workshop have numbered thirty-six during the past winter. In chemistry the increase in the students has considerably exceeded the accommodation available in the University laboratory, notwithstanding the existence of several college laboratories. Professors Liveing and Dewar plead strongly for further provision as regards both buildings and appliances, such as may bear comparison with those of Zurich and Bonn; they believe that to delay building until other departments can be adequately dealt with will be most detrimental to the present flourishing prospects of chemistry. A new register of the specimens in the mineralogical museum is completed; but the want of additional apparatus is seriously felt. Prof. Hughes records the use of the Arts School as a lecture-room, and the arrangement for additional class and work-rooms in the Woodwardian museum. The accessibility of the collections, and the determinations being kept up to date, attract many geologists who wish to pursue special investigations. Among the additions to the collections are 700 species of Pliocene shells from Tuscany, casts of vertebrates from Lausanne Miocene, 270 species of Miocene shells from the Vienna basin; Upper greensand corals from Devonshire, many Cretaceous specimens from the neighbourhood of Cambridge, 450 specimens from Neocomian of Saint Croix, Switzerland, and casts of *Hesperornis regalis*, Marsh, from Kansas; several hundred specimens from Portland Sands, Swindon, Wilts, collected by Mr. H. Keeping, the curator of the museum; numerous specimens of rocks and building-stones.

Turning, now, to the biological departments, the Woodward and Hepburn collections of shells have been carefully examined and catalogued by the curator, Mr. A. H. Cooke. The report gives notes upon the principal families of mollusca, as represented in the museum, with indications of gaps in the series; it should be widely circulated in the interest of the museum itself, as many old University students must have it in their power to supply deficiencies at a slight cost of trouble to themselves. Mr. Salvin reports that his catalogue of the Strickland collection of birds is complete, making an octavo volume of 653 pages. The species in the collection number 3125. Mrs. Strickland has presented a further portion of the valuable library of her late husband to the museum. In Amphibia and Reptilia the collection is still relatively poor. A beautiful skeleton of Menopoma has been prepared by W. Robinson, one of the assistants in the museum, and a considerable number of skeletons and skins of representative genera in these groups has been added. Among the mammalian acquisitions should be mentioned the skeleton of a male giraffe purchased from the Zoological Society; a skeleton of a mare, presented by Mr. R. Pryor, of Trinity College; skeletons of a ringed seal, a bladder-nosed seal, and a Polar bear, all carefully killed and preserved, so that the bones were neither injured nor missing, as is too often the case. A complete skeleton of an Indian elephant has been given by Sir John Phear, and a less perfect skeleton of an individual of the same species, sent from Calcutta through the kind exertions of Sir Joseph Fayrer. English additions of interest continue to be made, such as a male badger, an adult male otter from Norwich, and a female wild cat from Sutherlandshire.

The average number of students working at physiology practically is now over 100. Mr. Balfour's classes in practical morphology have very nearly attained the same numbers. More demonstrators are seriously needed. Mr. Vines has been assigned a small room for practical botany, but the advanced students can only do their work by the course being repeated two or three times, since only ten students can work at once. Elementary students are at present unprovided with any space for practical study.

Prof. Paget, in reporting on the department of medicine, strongly urges the speedy appointment of a Professor of Pathology, and the provision of a Pathological Laboratory. The Museum of Human Anatomy has been enriched by sixteen models of the brain and other models, prepared by the late Mr. Joseph Towne, modeller to Guy's Hospital, presented through Mr. T. Bryant.

One further note should be made, calling attention to the magnificent presents made to the Philosophical Library, on its transfer to the new room, and being made available for all students in the museums, by Mr. J. W. Clark, Prof. Humphry, Mr. F. M. Balfour, Prof. Babington, Prof. Newton, and others. Mr. Clark's gift is of priceless value to the science school, including as it does several hundreds of volumes of the most valued and superb editions of zoological and anatomical works.

The Hopkins Prize for the best original memoir, invention, or discovery in connection with mathematics physical or mathematics experimental science that may have been published during the three years immediately preceding, has been awarded to Lord Rayleigh, M.A., F.R.S., of Trinity College, Professor of Experimental Physics in the University, for his various important papers connected with the theory of vibrations, and particularly for his paper on "The Theory of Resonance."

Prof. Humphry announces practical classes in histology by the Demonstrator, Mr. Hill, and in osteology by Mr. Wheny, during July and August.

The Cavendish Laboratory will be open to students obtaining permission from the Professor during July and August, and the Professor or one of the Demonstrators will attend daily.

It has been decided to confer the Honorary Degree of LL.D. on Prof. J. P. Cooke, the eminent Professor of Chemistry in Harvard College, U.S.

The opening of the Botanic Garden during three hours on Sundays to members of the Senate and friends accompanying them has been confirmed by 88 to 76 votes.

MR. H. S. HELE SHAW has been appointed Professor of Engineering at University College, Bristol, vice Dr. J. T. Main, elected Assistant Professor of Mechanics at the Normal College of Science and Royal School of Mines, South Kensington. Mr. Sidney Young, D.Sc. London, succeeds Mr. W. L. Goodwin as Chemical Lecturer and Demonstrator, the latter having obtained the professorship of Sackville College, New Brunswick, Canada.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 11.—"On the Organisation of the Fossil Plants of the Coal-measures," part xii. By Prof. W. C. Williamson, F.R.S.

At the recent meeting of the British Association at York, Messrs. Cash and Hick read a memoir, since published in part iv. of vol. vii. of the *Proceedings* of the Yorkshire Geological and Polytechnic Society, in which they described a stem from the Halifax Carboniferous deposits characterised by a form of bark hitherto unobserved in those rocks. To this plant they gave the name of *Myriophylloides Williamsonis*. It was characterised by having a large cellular medulla, surrounded by a thin vascular zone composed of short radiating lamellæ. This, in turn, was invested by a cylinder of cortical parenchyma from which radiated a number of thin cellular laminæ, like the spokes of a wheel, separating large lacunæ. Each lamina generally consisted of a single series of cells. At their peripheral end, these laminæ merged in a thick, large-celled, cortical parenchyma. The generic name, Myriophylloides, was given to the plant because of the resemblance between sections of its cortical tissues and those of the recent Myriophyllum. Two reasons induced the author to object to this name (NATURE, December 8, 1881, p. 124), and to propose the substitution of that of Helophyton. Such substitution, however, was rendered unnecessary by the discovery, by Mr. Spencer, of Halifax, of some additional specimens which indicate that the supposed new plant was merely the corticated state of the Astromyelon, described by the author in his Memoir, part xi. (*Phil. Trans.*, 1878). These specimens showed that the plant was more complex than had been supposed, different ramifications of it having each their individual peculiarities.

In some of the new specimens the vasculo-medullary axes present no differences from those of the Astromyelon already described. The radiating lines of cells separating the laminæ prove to be transverse sections of elongated vertical laminæ composed of cells with a mural arrangement, and which separate large vertical lacunæ of varying lengths; a type of cortical tissue clearly indicating a plant of aquatic habits. So far as this bark is concerned, all the ramifications of the plant display similar features, but several of the specimens exhibit important variations in the structure of the vasculo-medullary axis. In them the central cellular medulla is replaced by an axial vascular bundle, which has little, or in some examples apparently no, cellular element intermingled with the vascular portions. In some examples this axial bundle is invested by the thick exogenous zone seen in Astromyelon. In others that zone is wholly wanting. Yet there appears to be no reason for doubting that these are but varied states of the same plant which branched freely, the differentiated branches having, doubtless, some morphological significances, as yet incapable of being explained. That the plant was a Phanerogam allied to Myriophyllum, is most improbable. It has several features of resemblance to the Cryptogamic Marsileæ, from which it does not differ more widely than the fossil Lepidodendra do from the living Lycopodiaceæ.

The author describes a new specimen of *Psaronius Renaultii*, found by Mr. Wild, of Ashton-under-Lyne. Those previously described, consisted almost entirely of fragments of the bark and its ærial rootlets. The present specimen contains a perfect C-shaped fibro-vascular bundle and a portion of a second one, resembling some of those described by Corda, and which leave no room for doubting that our British Coal-measures contain at least one arborescent fern, equal in magnitude to those obtained from the deposits at Autun.

In his Memoir, Parts IX. and X., the author described, under the provisional generic name of Zygosporites, some small spherical bodies with furcate peripheral projections. Similar bodies had been met with in France, and were regarded by some of the French palœontologists as true Carboniferous representatives of the Desmidiaceæ. The author was unable to accept this conclusion, deeming it much more probable that they would prove to be spores of a different kind. Mr. Spencer exhibited the specimen now described at the York meeting. It is a true sporangium, containing a cluster of these Zygosporites. Though they undoubtedly bear a close superficial resemblance to the zygospores of the Desmidiæ, their inclosure within a common sporangium demonstrates them to be something very different. There is now no doubt but that they are the spores of the strobilus, described by the author in his Memoir, Part V., under the name of *Volkmannia Dawsoni*. Hence the genus Zygosporites may be cancelled.

Another interesting specimen found by Mr. Wild, is a young Calamite, with a more curiously differentiated bark than any that has hitherto been discovered. The structure of the vascular cylinder and of the innermost layer of the bark, differs in no essential respect from those previously described; but the outermost portion displays an entirely new feature. It consists of a narrow zone of small longitudinal prosenchymatous bundles, each one having a triangular transverse section, the apex of each section being directed inwards, whilst their contiguous bases are in contact with what appears to be a thin epidermal layer. As in every previously discovered Calamite in which the cortex is preserved, the peripheral surface of this specimen is perfectly smooth or "entire." It displays no trace of the longitudinal ridges and furrows seen in nearly all the traditional representations of Calamites figured in our text-books.

It has long been seen that the medullary cells of the Lepidodendra, as well as the vessels of their non-exogenous medullary sheaths, steadily increased in number as these two organs increased in size correlatively with the corresponding general growth of the plants. But the way in which that increase was brought about has continued to be a mystery. The author now describes a Lepidodendron of the type of *L. Harcourtii* in which nearly every medullary cell is subdivided into two or more younger cells, showing that, when originally entombed, the pith was an extremely active form of meristem, though the branch itself had attained to a diameter of at least two inches. The numerous small young cells are of irregular form. Their development by further growth into a *regular* parenchyma would inevitably necessitate a corresponding increase in the diameter of the branch as a whole; and it must have been from these newly-formed cells that the medullary cylinder obtained the element out of which to construct the additional vessels, the increase of which has been shown to be the invariable accompaniment of the growth of the branch. As might be expected, the growth of the vascular cylinder, or medullary sheath, could only have been a centripetal one.

A new form of Halonia from Arran is described. Instead of its central portion consisting, as in previously-described examples, of the usual Lepidodendroid medulla surrounded by a vascular cylinder, it consists of a solid axis of vessels, resembling in this respect all the very young Lepidodendroid twigs previously described from the same locality. Many recently obtained specimens of Lepidodendroid branches sustain the author's previous observations that all examples from Arran having less than a certain diameter, have the solid axial bundle, whilst all above that diameter have a cylindrical vascular bundle inclosing a cellular medulla. The first type commences with the smallest twigs, and is found increasing gradually up to the diameter referred to. The second type begins where the other ends, and increases in diameter until attaining the dimensions of the largest stems, in none of which does the solid bundle reappear. Halonial branches have not hitherto been described attached to the branches of any true Lepidodendron, though in 1871 (Memoir, Part II.), the author gave reasons, based upon organisation, for insisting that Halonia was a fruit-bearing branch of a Lepidodendroid tree. This conclusion was sustained by Mr. Carruthers in 1873 in his description of a branch belonging to a Lepidophloios. The author now figures a magnificent example, from the museum of the Leeds Philosophical Society, of a dichotomous branch of a true Lepidodendron of the type of *L. elegans* and *L. selaginoides*. In this specimen every one of the several terminal branches bears the characteristic Halonial tubercles. The leaf scars of these latter branches have the rhomboid form, once deemed characteristic of the genus Bergeria, whilst those of the lower part of the specimen are elongated as in *L. elegans*, &c. These differences are not due to their appearance in separate cortical layers of the branch, but to the more rapid growth in length of its lower part compared with its transverse growth.

The author throws some additional light upon the structure of Sporocarpum ornatum, described in Memoir, Part X., as also upon the nature of the development of the double leaf-bundles seen in transverse sections of the British Dadoxylons, described in Memoir IX. After a prolonged but vain search for a structure similar to the latter amongst the twigs of the recent Conifers, the author has at length found it in the young twigs of the *Salisburia adiantifolia*. Sections of these twigs made immediately below their terminal buds exhibit this germinal arrangement in the most exact manner. Pairs of foliar bundles are given off from the thin, exogenous Xylem zone which encloses the medulla, whilst at the same points the continuity of the Xylem ring is interrupted, as was also the case with the Dadoxylons, by an extension of the medullary cells into the primitive cortex. Sections of the petiolar bases of the leaf-scales of the bud show that these bundles enter each petiole in parallel pairs, subsequently sub-dividing and ramifying in the Adiantiform leaf. This curious resemblance between Salisburia and Dadoxylon, accompanied as it is by other resemblances in the structure of the wood, bark, and medulla, suggest the probability that our British Dadoxylon was a Carboniferous plant of Salisburian type, of which Trigonocarpum may well have been the fruit. If so, the further possibility suggests itself that this plant may have been the ancestral form whence sprang the Baieras of the Oolites, and, through them, the true Salisburias of Cretaceous and of recent times.

Linnean Society, May 4.—Sir J. Lubbock, Bart., F.R.S., president, in the chair.—Dr. Cuthbert C. Gibbes was elected a Fellow.—The Council and Fellows passed a resolution of sympathy with the family of the late Mr. Chas. Darwin.—The Rev. R. P. Murray called attention to specimens of *Carex montana* obtained at Heathfield, Sussex, corroborating Mr. Roper's late rediscovery of the plant in that county.—Mr. J. Murison exhibited dried examples of *Helipterum eximium* from the Cape, of *Ixodia achilleoides* from South Australia, and of jungle cotton from Nagpoor.—A paper was read, on a collection of algæ from the Himalayas, described by Prof. G. Dickie.—A communication was made, referring to new varieties of the sugar-cane produced by planting in apposition, as asserted by experiments of the Baron de Villa Franca and Dr. Glass of Rio de Janeiro. In correspondence which had passed between the authors and Mr. Chas. Darwin, the latter had expressed doubts as to whether two varieties could affect the character of the buds produced by either, it appearing more probable to him that the so-called new variety was due to bud-variation. The Baron de Villa Franca thereupon forwarded a document signed by eight distinguished Brazilians, testifying to the fact that valuable varieties have been raised by the process in question. Dr. Glass furthermore describes in detail his early but fruitless attempts to graft two varieties of the sugar-cane, though he succeeded with another monocotyledon, viz. *Dracæna*.—Mr. S. Grieve gave a notice of the discovery of remains of the Great Auk (*Alca impennis*) on the Island of Oronsay, Argyllshire. Wing and leg-bones were obtained, along with a various assortment of remnants of the Guillemot, Red Deer, Otter, Seal, and other mammals, mingled with fish-bones and shells. These were dug out of a large mound, which, the author believes, must in early times have been occupied by man. The exceeding rarity of the Garefowl remains in Britain gives a special interest to the record of their being found in these western Scottish Isles.—Then followed the reading of notes on some Cape orchids, by Mr. Harry Bolus, wherein several new species were described, and details given in elucidation of particular structural points in the flowers of certain forms, accompanied by a full list of the Cape orchids named by previous writers.—A note was read, on the dimorphic florets of *Catananche lutea*, by Mr. B. D. Jackson, which was followed by a paper on the clasping organs auxiliary to the generative parts in certain Lepidoptera, by P. H. Gosse. After some general remarks the latter author mentioned his mode of manipulation, and proceeded to a description of the organs in question, finally dealing with the modification of the apparatus as investigated in a very considerable number of species.

Zoological Society, May 16.—Osbert Salvin, F.R.S., vice-president, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of April, 1882, and called special attention to the following birds, all of which were said to be new to the collection:—(1) a male Rifle-bird (*Ptilorhis paradisea*), in immature and worn plumage, changing very slowly into the adult dress, but apparently in good health; (2) a pair of Black-headed Tragopans (*Ceriornis melanocephala*); (3) four Rüppell's Parrots (*Pœocephalus rueppelli*), from Western Africa; (4) a Western Black Cockatoo (*Calyptorhynchus naso*), conspicuously differing from the eastern *C. banksi* in its smaller size; (5) a male Cabot's Tragopan (*Ceriornis caboti*), making a fine addition to the gallinaceous series; and (6) two of the recently described Uvæan Parrakeet (*Nymphicus uvæensis*).—There was exhibited, on behalf of Mr. Henry Stevenson, a specimen of the Dusky Petrel (*Puffinus obscurus*), which had been picked up dead in the neighbourhood of Bungay, Norfolk, in 1858.—A communication was read from the Rev. O. P. Cambridge on some new genera and species of *Araneidea*. Of the sixteen species described, two were from Caffraria, one from St. Helena, two from Ceylon, and the remaining eleven from the Amazons.—Mr. W. A. Forbes called attention to a peculiarity recently observed in a young male specimen of *Pithecia satanas*, in which the third and fourth digits of both hands were completely "webbed."—Mr. W. A. Forbes also read a paper on certain points in the anatomy of the Todies (*Todus*), and on the affinities of that group. He dissented from the views of most previous authors as to the close affinities of these birds to the *Momotidæ*, considering that they must form a group by themselves, to be called *Todiformes*, of value equivalent to the *Pici-*, *Passeri-*, and *Cypséli formes* of Garrod. There were many grounds for supposing that *Todus* is a very ancient form, more nearly representing the ancestors of the whole group of Anomalogonatous birds than any other living form.—A communication was read from Mr. Roland Trimen, F.Z.S., containing a description of an apparently undescribed Sun-Bird obtained in the province of Mossamedes, South-western Africa, which he proposed to name *Cinnyris erikssoni*, after its discoverer Mr. Abel W. Eriksson.—Mr. P. L. Sclater read some notes on a species of Duck (*Anas gibberifrons*), examples of which had recently bred in the Society's Gardens.—Mr. W. E. Forbes gave an account of some points in the anatomy of a rare Australian Duck *Biziura lobata*) from examples that had recently died in the Society's Menagerie.

Physical Society, May 20.—Prof. Fuller in the chair.—Prof. W. Chandler Roberts, F.R.S. communicated the results he had obtained in repeating the experiments of M. W. Spring, Professor at the University of Liége, on the union of finely-divided particles of metal by pressure. M. Spring had shown that at a pressure varying from 5000 to 7500 atmospheres, metallic filings may be united into coherent discs. Thus at a pressure of 6000 atmospheres bismuth filings may be united into a disc which has a crystalline fracture and a density which is identical with that of the metal cooled from the molten state. Zinc again, also a very crystalline metal, will weld into a disc at a pressure of 7000 atmospheres, and the metal will even "flow" into cracks between the die and the collar surrounding it, just as in the experiments of M. Tresca, lead "flowed" under similar circumstances. Prof. Roberts had repeated and confirmed many of the experiments of M. Spring, whose more recent results are of special interest, as he has shown that if filings of bismuth, lead, and cadmium be *mixed* in suitable proportions, such, for instance, as in Wood's alloy; and if the mixture be submitted to a pressure of 7500 atmospheres, an *alloy* is obtained which will actually fuse at 70° C. the true fusing point of Wood's alloy being 63° C. Prof. Roberts showed to the Society an alloy he had prepared which melted below 100° C., although of the constituent metals the lowest melting-point is 230° C., and he pointed out the great interest both to the physicist and metallurgist of M. Spring's results.—Mr. Walter Baily then showed mathematically that the repulsion between the magnet and revolving copper disc in the experiment shown by Prof. Guthrie at the last meeting of the Society ought to vary as the square of the velocity of rotation of the disc, a result which Prof. Guthrie had found.—Mr. Lecky gave the results of tests of Mr. Bennet's cell (described at the last meeting) made by Prof. Guthrie. The electromotive force was 1·14 volts; the internal resistance 0·8 ohms, but both quantities vary under certain conditions. Prof. Macleod also gave the results of tests made by him. These show that the cell rose in E.M.F. from 1·005 volts on changing to 1·213 volts after standing three days. The internal resistance was then 1·007 ohms. Both quantities varied under different conditions of working.—Mr. C. V. Boys then exhibited an improved form of his vibratory meter for measuring electric currents, and specially designed for electric lighting purposes. He has applied to the form formerly shown to the Society, the contact-making device employed in Hipp's electric clocks, which, though imperfectly adaptable to the clocks, is perfectly adaptable to the meter. The force is proportional to the displacement. No sliding contacts are employed. Mr. Boys also explained some other plans for current meters, one of which he believes to be the final form for practice, and which, besides being remarkably simple in construction, is free from the objection of being tampered with by means of extraneous magnets. In reply to Prof. Foster he stated that self-induction does not disturb their action.

PARIS

Academy of Sciences, May 22.—M. Jamin in the chair.—The following papers were read:—Note on the application of a theory of Poncelet to approximate calculation of the arcs of plane curves, by M. Resal.—Researches on the absorption of gases by platinum, by M. Berthelot. He investigates the liberation of heat in absorption of hydrogen and oxygen by platina in different states. It is shown that the state of porous bodies changes continually while they absorb gases.—Action of oxygenated water on organic substances and fermentations, by MM. Bert and Regnard. *Inter alia*, dilute oxygenated water stops fermentations due to living organisms, and putrefaction of all substances which do not decompose it; it does not act on diastasic fermentations. It is rapidly destroyed (under 70°) by collagenous azotised matters, by musculine, blood fibrine, and azotised vegetable matters; but not by fats, amylaceous matters, soluble ferments, egg albumen, caseine, peptones, creatine, creatinine, or urea.—Reply to objections made by M. de Lesseps in the last *séance*, by M. Cosson.—A new scientific cruise of the *Travailleur* in the Atlantic, in July and August, as far as Madeira and the Canaries, was announced by M. Alph. Milne-Edwards.—M. Demontzey was elected Correspondent in Rural Economy, in room of the late M. Pierre.—On the measurement of carbonic acid contained in the atmosphere, by M. Mascart. He describes a method based on direct measurement of the diminution of pressure of a mass of air at constant volume and temperature, when the CO_2 is removed. Travellers may take about 500 cc. of air in glass tubes sealed at a lamp, and afterwards analyse at leisure.—Quantity of carbonic acid contained in the air at Colèves, near Nyon (Switzerland), altitude 430 m., by M. Risler. The general average for three years is 3·035 vols in 10,000.—Inoculability of tuberculosis by respiration of consumptives, by M. Giboux. In these experiments air expired by animals in phthisis was introduced twice a day for 105 days into a wooden case containing young rabbits, the grated apertures of the case being closed for two hours. Tubercles appeared in the rabbits' lungs. Other rabbits in a similar case, and similarly treated, except that the infected air was passed through carbolised wadding, showed no organic alteration.—Researches of pathological physiology on respiration, by MM. Grehant and Quinquaud. In the case of bronchial, pulmonary or pleural alterations, even in fever, the exhalation of carbonic acid is considerably diminished. The lesion, apparently, does not act by barring the elimination of CO_2, so that this accumulates in the blood, but by interfering with general nutrition at the various points where CO_2 if formed.—On the persistence of effects of preventive inoculation against symptomatic *charbon*, and on the transmission of immunity of the mother to her product in the bovine species, by MM. Arloing, Cornevin, and Thomas. The persistence of immunity for seventeen months has thus far been verified.—Observations serving in the study of phylloxera, by M. Lichtenstein.—Telegram from Cairo about the solar eclipse.—On the observations of the telescopic comet at the Imperial Observatory of Rio de Janeiro, by M, Cruls.—On a new case of formation of the dark ligament, and its utility for observation of the transit of Venus, by M. André. This was observed, during the recent eclipse, by MM. Gonessiot and Marchand, where the moon's disc came on three sun-spots. The ligament is much less dark than in the case of the transit. Here the laws of diffraction can alone explain it.—On a class of invariants relative to linear equations, by M Poincaré.—On uniform functions affected by sections, by M. Picard.—On the chemical work produced by the battery, by M. Tommasi.—On the employment of rotating discs, for the study of colour-sensations; relative intensity of colours, by M. Rosenstiehl.—Influence of introduction of the interior sea on the *régime* of Artesian sheets of water in the region of the Chotts, by M. Dru. These Artesian sheets would not be destroyed, but the general *régime* of waters in the country would be improved and protected.—Sulphhydrate of sulphide of nickel, by M. Baubigny.—Action of alkaline sulphides on proto-sulphide of tin, by M. Ditte.—Researches on cuproso-cupric sulphites, by M. Etard.—Basic salts of protoxide of manganese, by M. Gourgeu.—On the addition of hypochlorous acid to monochlorinated chloride of allyl, by M. Henry.—The odd eye of Crustaceans, by M. Hartog. It is composed of three simple eyes, anterior to the brain, with optic rods reversed, receiving the conductive fibres of the optic nerve on their external border, and having the pigment layer confounded in one mass. A similar structure is found in Chætognatha and in some Planaria. To this primitive and ancestral group of Turbellaria, the eyes of Crustacea and Chætognatha may probably be referred.—Researches on flagelliferous Infusorians, by M. Kunstler.—On a bed of tertiary mammalia at Aubignas (Andèche), by M. Torecarpel.—Influence of ethylic alcohol, and of essence of absinthe on the motor functions of the brain, and on those of the muscles of the life of relation, by M. Danillo. The influence of alcohol (in strong doses) referred to is similar to that of other anæsthetics (ether, chloral, morphine). Five periods are distinguished in the case of essence of absinthe, a tonic, a clonic, a choreïform, a period of delirium, and one of resolution. Thus the poisoning is like that from strychnine, in which, however, the period of delirium is absent.

VIENNA

Imperial Academy of Sciences, April 20.—L. I. Fitzinger in the chair.—The following papers were read:—Fr. Brauer, on the *segment mediare* of Latreille.—R. Maly, on the ratio of bases and acids in blood-serum and other animal fluids; a contribution to the theory of secretion.—Fr. Emich, on the behaviour of ox-bile to Huefner's reaction, and on some properties of glycocholic acid.—T. Mauthner, on the optic-rotatory power of tyrosine and cystine.—G. Becka, on the orbit of the planet Ino (No. 173).—E. Suess, on Fr. Bassani's work, "Discrizione dei pisci fossili di Lesina."—T. V. Rohon, on the origin of the nervus acusticus in Petromyzon.—F. T. Paulsen, on the path of the air-stream in the nasal cavity of man.—O. Simony, on a series of new mathematical principles derived from experience.

May 4.—L. I. Fitzinger in the chair.—The following papers were read:—C. Doelter, on the mechanical separation of minerals.—G. Gruss, on the orbit of the "Loreley" (165).—O. Seeliger, on the history of development of the Ascidia.—S. Lustgarten, on test for zodoform, naphthol, and chloroform in animal liquids and tissues.—A. Wassmuth, on the specific heat of strongly magnetised iron and on the mechanical equivalent of a diminution of the magnetism by heat.—T. V. Tanovsky and H. v. Perger, a sealed packet containing a paper on a new reaction of the azo-bodies.—A Brezina, report on some new and little-known meteorites (part iv.)—Z. A. Skraup, synthetical experiments on the chinolin series (part iii.).—R. Wegscheider, on the derivates and constitution of opianic and hemipinic acid.—A. Boehm, on the tertiary fossils of the Isle of Madura.

BERLIN

Physiological Society, May 19.—Prof. du Bois-Reymond, president.—Dr. Rabt Rückard spoke about the development of the brain in fishes, and about the import of its so-called lobi optici. He especially combated the view that the part covering these lobes is a part of the cerebrum; he is, on morphological, histiological, and embryological grounds, rather of the opinion that this portion of the brain belongs to the middle brain, and that it is an homologue to the corpora quadrigemina in the brain of the higher orders of animals. He endeavoured to establish this view by the history of the development of the brain in fishes, which he made a minute study of in the trout.—Prof. Hirschberg laid before the Society the results of his dioptric measurements of the eyes of fishes and amphibia (pikes and frogs), as a further contribution to the comparative dioptrics of the eye. According to his measurements, the cornea in the pike has a large radius of curvature which exceeds the length of the optic axis; consequently, these animals are very myopic in the air; when, however, the eye was ophthalmometrically examined under water, the distance of distinct image formation was much greater. The eye in fishes (both those of the pike and roach were examined) behaves quite differently in air and in water. This fact is a contradiction of Herr Rateau's statements, who also found the seeing distance of fishes almost the same in both media. The eye of the frog also behaves differently in water from what it does in air; the radius of curvature of its cornea is much smaller in proportion to the length of the optic axis, and its myopia in air is much less than in fishes. It is remarkable, that in the case of the eyes of both the frog and the pike, neither a solution of atropine nor of eserine produced any alteration in the distance of the formation of images; it is hence probable that the accommodation of the eye, if it occur at all in these animals, takes place by some other mechanism than that which affects it in the higher vertebra.

CONTENTS

THURSDAY, JUNE 8, 1882

ANTS, BEES, AND WASPS

Ants, Bees, and Wasps; a Record of Observations on the Social Hymenoptera. By Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D., Pres. B.A. and L.S., &c. International Scientific Series, Vol. XL. (London: Kegan Paul, Trench, and Co., 1882.).

SIR JOHN LUBBOCK has done well to gather all the results of his serially published observations on the social hymenoptera in one treatise, and to bring out the treatise in the International Scientific Series. On the one hand the extensive and important research on which he has for so many years been engaged is thus presented to the naturalist no longer in the form of scattered papers, and on the other hand the International Scientific Series, both on account of its popularity at home, and of its well-organised machinery for securing rapid translations abroad, is the most suitable place for publishing results which are in so eminent a degree of interest to general readers.

Looking to the investigations as a whole, or in the connected form in which they are now presented, we think that they deserve to be considered the most scientifically methodical, as well as in many respects the most scientifically fruitful, which have hitherto been prosecuted in the region of comparative psychology. In saying this we do not forget the investigations of Reaumur, Huber, Forel, Darwin, Moggridge, McCook, Morgan, or Spalding—all of whom we regard as holding more substantial claims to recognition in this respect than many others who might be mentioned in the same connection. But when we compare the researches of Sir John Lubbock with those of any other comparative psychologist, we find that he has the merit of showing, if not the greatest appreciation of scientific method, at least the greatest determination in applying such method to the questions with which comparative psychology has to deal. Darwin and Spalding are the only other men who in this department of science have shown an adequate estimate of the importance of experiment as distinguished from observation; but neither Darwin nor Spalding had time to experiment in psychology on a large scale—the former having had so many other lines of inductive and deductive research to attend to, and the latter having died so young. Thus it is that when we compare the investigations of Sir John Lubbock with those of other workers in the field of animal psychology, we must assign to him the first place among these workers as a scientific observer.

For the most part the volume before us is a reprint of the papers read before the Linnean Society, with only as much re-casting as is rendered necessary to give a systematic form to the book. A few coloured plates, however, are added, as well as a brief account of some of the chief facts recorded by other observers of ants. The latter, indeed, is slender, and is not even attempted in the case of bees; so that the essay is strictly, as its title proclaims, "A record of observations on the social hymenoptera"; it is not an account of all that we know concerning the psychology of these animals. As the essay is sure to attain a wide popularity, it is perhaps to be regretted that its author did not take the opportunity of disseminating complete information upon so interesting a subject, together with the "record" of his own "observations." But this is a matter on which opinions are likely to differ, and there can be no doubt that within the scope laid down by its title, the work is admirably arranged.

We shall now proceed briefly to enumerate the principal results which this record of observations sets forth.

The longevity of ants has been found to be much greater than was formerly supposed, for while previous observers were for the most part of the opinion that these insects die off every year, Sir John says:—

> "I have now (December, 1881) two queens which have lived with me since the year 1874. They must therefore be at least seven years old, and seem still quite strong and well. I have also some workers which I have had in my nests since 1875."

The following facts and opinions on questions of morphology may be quoted;—

> "I must regard the ancestral ant as having possessed a sting, and consider that the rudimentary condition of that of Formica is due to atrophy, perhaps through disuse."

Some species have the power of ejecting their poison to a considerable distance—as much as eighteen inches—and this power might have led to the sting falling into disuse, especially if the poison is, as it appears to be, "so intensified in virulence as to act through the skin."

> "The question arises whether the different kinds of workers are produced from different eggs. I am disposed to agree with Westwood in the opinion 'that the inhabitants of the nest have the instinct so to modify the circumstances producing this state of imperfection, that some neuters shall exhibit characters at variance with those of the common kind.'"
>
> "Among bees and wasps the workers are occasionally fertile; but so far as our observations go, it is a curious fact that their eggs never produce females, either queens or workers, but always males. . . . It became therefore an interesting question whether the same is the case among ants, and my nests have supplied me with some facts bearing on the question."

These facts consist of numerous cases of fertile eggs having been laid by workers, and in every case with the result of producing a male insect.

With regard to psychology, we have only space to allude briefly to the more important results.

Experiments showed that certain individual ants in a community "are told off as foragers, and that during winter, when little food is required,' two or three are sufficient to provide it."

Observations concerning sympathy and affection went to show, that while in most cases such feelings seemed to be entirely absent, in some cases they seemed to be certainly present. This was so in an instance observed last year, of a "poor ant lying on her back, and quite unable to move." Her companions moved her tenderly, for whenever Sir John "tried uncovering the nest where she was, the other ants soon carried her into the shaded part," and when they left the nest for an airing, they carried the invalid with them.

It was previously known that all the ants in the same nest recognise one another as friends. Sir John tried chloroforming and intoxicating certain individuals, to see whether this would prevent their being so recognised.

The chloroformed ants were treated by their companions as dead, but the intoxicated ones were recognised and taken into the hive, while intoxicated strangers were rejected. The manner in which recognition is effected has long been a standing puzzle to observers, and although Sir John Lubbock has not shown "how it is done," he has at least shown very conclusively how it is *not* done. Previous hypotheses supposed the faculty to depend on recognising personal appearance, personal scent, or on there being some pass-signal understood by all the members of a hive, and not known to members of other hives. But Sir John has found that the recognition is effected when the pupæ are hatched out away from their native hive, and even when the eggs are developed in one half of a divided hive, and the matured insects then returned to the other half. He also found that the memory of companions or nest-mates extends over at least a year and nine months.

Regarding the power of communication, the experiments went to show a strange uncertainty, though they agree with previous observations in establishing the main fact that such a power exists. Thus, for instance, when a dead fly was pinned down so that the ant which found it could not drag it towards the nest, she returned to the nest and procured assistance. This experiment was repeated, with small variation, a great number of times, and certainly proves a power of communication at least to the extent of "follow me." Moreover, by an ingenious device with three parallel tape bridges extending from a nest to three similar glasses, one empty, another holding a few larvæ, and the third filled with many larvæ, Sir John was able to show the interesting fact that ants can give definite information to one another as to locality, without requiring merely to lead the way. For he took two ants and placed one of them to the glass with many larvæ, and the other to that with a few. Each of them took a larva, carried it to the nest along the respective tapes, returned for another, and so on. After each journey he put another larva in the glass with a few larvæ to replace the one which was taken away. Every new ant which came to either of the glasses was imprisoned till the end of the experiment. Such being the conditions, it was observed that no ants went along the tape bridge to the empty glass, 104 ants went to the glass with a few larvæ, and 304 to the glass with the many larvæ. Thus it seems that the two original (marked) ants were able to tell their companions, not only where larvæ were to be found, but even where the largest store was to be met with.

Concerning the powers of special sense, a large number of experiments proved that ants are able to appreciate colour, and when their nests are covered with slips of stained glass, analysis of some of these experiments showed that there had congregated "under the red 890, under the green 544, under the yellow 495, and under the violet only 5." Other experiments showed that red light was the same to them as darkness, or, at least, that about the same proportion of ants congregated under red glass as congregated under a slip of porcelain. With reference to the parts of the spectrum invisible to our eyes, other experiments proved "that the limits of vision of ants at the red end of the spectrum are approximately the same as ours, that they are not sensitive to the ultra-red rays; but, on the other hand, that they are very sensitive to the ultra-violet rays." A layer of sulphate of quinine or of bisulphide of carbon had the effect, as might be supposed from the latter statement, of rendering the ultra-violet rays invisible, or less obnoxious to the ants. Conversely, a saturated solution of chrome alum, and chromium chloride in a layer so thick that in the darkness beneath it the ants could not be seen, had the effect of inducing the ants to escape from its luminosity to their eyes, and to go beneath the bisulphide of carbon; so that, "though to our eyes the bisulphide of carbon is absolutely transparent, while the chrome alum and chromium chloride are very dark, to the ants, on the contrary, the former appears to intercept more light than a layer of the latter."

A number of elaborate experiments on the sense of hearing produced only negative results, though from other considerations (chiefly anatomical) Sir John concludes, "On the whole, though the subject is still involved in doubt, I am disposed to think that ants perceive sounds which we cannot hear." Experiments on the sense of smell showed that the estimate previously formed by naturalists of its excellence was not exaggerated.

A number of experiments on the general intelligence of ants in overcoming difficulties of various kinds which Sir John devised for them, went to indicate a poverty of resources scarcely to have been expected; but it must be remembered that this only shows that there are ants and ants, for other trustworthy observers give wonderful accounts of the high intelligence of certain foreign species. On the subject of way-finding, there are also many interesting observations, which show that sight is not of nearly so much service as smell, although it is of much use in giving them their general "sense of direction;" for they observe the direction in which light is shining, guide themselves accordingly, and lose themselves if turned partly round on a rotating table in the dark.

We must not leave these chapters on ants without referring to one on the relation of these insects to plants, and another on their relation to animals. It is of importance to many species of plants that they should not be visited by ants, as the presence of these insects would tend to keep away bees, &c., which are required to fertilise the flowers. Consequently, these species of plants present a great variety of contrivances to exclude the ants, such as water-traps, slippery surfaces, narrow passages, sharply-curved stalks, hairs, viscid secretions, &c. Instances of such contrivances are given, and the general conclusion is stated that "though ants have not influenced the present condition of the vegetable kingdom to the same extent as bees, they have also had a very considerable effect upon it in various ways." Concerning the relation of ants to other animals, the most interesting addition to our knowledge which Sir John has made is that of *Lasius flavus* farming the eggs of aphides. For "here are aphides, not living in the ants' nests, but outside, on the leaf-stalks of plants. The eggs are laid early in October on the food-plant of the insect. They are of no direct use to the ants, yet they are not left where they are laid, exposed to the severity of the weather and to innumerable dangers, but brought into their nests by the ants, and tended by them with the utmost care through the long winter months until the following March, when the young ones are brought out and again placed on the young shoots of the daisy. . . . Our ants may not perhaps lay up food for the winter (like the harvesters), but they do more, for they keep during six months the eggs which will enable them to procure food during the following summer, a case of prudence unexampled in the animal kingdom."

Only one chapter of the book is devoted to bees, and one other to wasps. These, however, are very interesting, as the following *résumé* will show:—

Numerous observations went to prove "that bees do not bring their friends to share any treasure they have discovered so invariably as might be assumed from the statements of previous writers;" and also that in general bees are rather stupid in finding their way to honey out of rooms, &c. Their affection and sympathy is even less developed than in ants, so that Sir John doubts "whether they are in the least fond of one another." Their special senses are much the same as those of ants, hearing being to all appearance absent, while smell and sight are well developed, the latter enabling the insects to distinguish differences of colour on coloured surfaces. They prefer blue.

All these remarks apply to the experiments on wasps no less than to those on bees, except that they are somewhat more clever in finding their way, and show less preference for certain colours. One individual wasp was tamed, used to perch upon the hand, "apparently expecting to be fed," and even allowed herself to be stroked without any appearance of alarm.

We have now said as much as our space permits to recommend this work to all who take an interest in one of the most interesting branches of natural history. We can only find two points on which to offer criticism. Over a hundred pages are occupied with appendices, conveying minute details of the observations and experiments mentioned in the previous part of the work. These details appear to us unnecessary in a popular book, and we think that the space filled by them might have been more profitably devoted to a well compressed abstract of the observations of other naturalists upon the psychology of the hymenoptera.

The second point, which seems to us fairly open to criticism, is that concerning the author's views on the philosophy of vision. He discusses the theories of vision by simple and compound eyes of insects, and says, "The prevailing opinion of entomologists now is that each facet receives the impression of one pencil of rays; so that, in fact, the image formed by a compound eye is a sort of mosaic," and proceeds to observe that this theory "presents great difficulties," because "those ants which have very few facets must have an extremely imperfect vision," and also because the ants have simple eyes as well as compound, so that, according to the theory, the former cast reversed images, and the latter direct—a consideration which leads Sir John to remark, "that the same animal should see some things directly, and others reversed, and yet obtain definite conceptions of the outer world, would certainly be very remarkable."

Now, as regards the first objection, the perfection or imperfection of the vision would not necessarily be determined by the *number* of the facets any more than by their *size*. If a given area or eye-space is throughout a receptive surface, it need make no difference whether the area is composed of a few facets or of many; the perfection or imperfection of the apparatus as an eye would in either case depend on the distinctness or definition with which a pencil of rays is admitted into each facet, whether the pencil itself be wide or narrow.

And, as regards the second objection, we can see no real difficulty in supposing that the same animal should with some of its eyes see direct images and with others reversed images, without any confusion resulting to its mental perceptions. Let us first consider the case of reversed images. Sir John Lubbock says that we "see everything really reversed, though long practice has given us the right impression." But this statement is not quite correct. We do not really *see* things reversed, for the mind is not a perpendicular object in space standing behind the retina in the manner that a photographer stands behind his camera. To the mind there is no up or down in the retina, except in so far as the retina is in relation to the external world, and this relation can only be determined, not by sight, but by touch. And if only this relation is *constant*, it can make no difference to the mind whether the images are direct, reversed, or thrown at any angle with reference to the horizon; in any case the correlation between sight and touch would be equally easy to establish, and we should always *see* things, not in the position in which they are *thrown upon* the retina, but in that which they occupy *with reference to* the retina. Thus it really requires no more "practice" correctly to interpret inverted images than it does similarly to interpret upright images, and therefore the fact that some eyes of an ant are supposed to throw direct images, while others are supposed to throw reversed, is not any real objection to the theory which Sir John Lubbock is considering.

We give these criticisms as the only ones we have found it possible to make, and heartily wish so interesting a book the success which it deserves.

GEORGE J. ROMANES

OUR BOOK SHELF

The Great Giant Arithmos, a Most Elementary Arithmetic. By Mary Steadman Aldis. (London: Macmillan, 1881.)

"THERE are still mothers who wish to retain some portion of that influence which nature intended them to have in the training of their children, and who refuse to abandon it wholly either to the schoolmaster or the state. To such as these this little book is offered as a help in laying the foundations of one of the most important branches of instruction." In fifty-eight chapters the tender student is led pleasantly, clearly, and thoroughly, from the very simplest notions which lie at the threshold of arithmetic till he (or she), having solved many of the giant's easy riddles, is in a very good position to find out for himself some of the harder ones. We should say that the child who has had this course carefully laid before it, will have had its interest maintained throughout without flagging, for the mode of presenting the subject is such as to excite attention without causing fatigue. The lessons are all short, the questions pointed, and such as to draw out what knowledge has been acquired. Very little more is done than to explain the elementary operations of numeration, addition, subtraction, multiplication, and division. Towards the close a glance is given at some of the giant's more recondite mysteries, as of parts or fractions of things. Much useful, if elementary, information is conveyed in small doses as the child is able to receive it, but there is nothing childish in the matter or the manner. We should say that the best way to use the book would be for the parent (or governess) to master each lesson well beforehand, so that there should be little or no reference to the book during lesson-time, except, perhaps, for the purpose of looking at the illustrative drawings. We feel sure that when the "good bye" is reached there will be few to call Arithmos unkind names and say "he is a horrid, cross old thing," and that "they hate him, and wish such a giant had never been made."

A Treatise on Elementary Trigonometry. By the Rev. J. B. Lock. (Macmillan, 1882.)
Introduction to Plane Trigonometry. By the Rev. T. G. Vyvyan. (Deighton, Bell, and Co., 1882.)

BOTH these works are elementary: their scope is in the main limited by the requirements of the Previous Examination at Cambridge, and of the Entrance Examinations for the army. Mr. Lock's is by far the fuller work, and is well adapted for a student who has not constantly at hand the assistance of a private tutor; in fact, such a reader, if of fair intelligence, might be independent of extraneous aid, if he have previously grounded himself carefully in geometry and elementary algebra. The work contains a very large collection of good (and not too hard) examples. The only fault—if we must grumble—is that there is too much, we think, for ordinary school teaching. As Mr. Vyvyan remarks, "in all public schools but a few hours a week can be given to mathematics by the generality of boys," and trigonometry has to take, in general, a very small portion of that limited time. But Mr. Lock is to be congratulated, when so many "Trigonometries" are in the field, on having produced so good a book, for he has not merely availed himself of the labours of his predecessors, but by his treatment of a well-worn subject has invested the study of it with interest. The figures are numerous, and are drawn so that the salient features arrest the eye at once.

Mr. Vyvyan's work also is well adapted to the end he has in view. He aims at producing a book which may fairly be mastered by any schoolboy of average ability, whose sole desire in studying this branch (or any other branch of mathematics) is to satisfy the University examiners in an early stage of residence, that so he may be free to read other subjects, and bid farewell to mathematics.

The matter is clearly, though somewhat concisely put, and is sufficient in quantity for Mr. Vyvyan's purpose, which is not to bring out a book that will render a schoolboy or other junior student independent of the assistance of a master—this he considers to be an impossible task. We ourselves have found that very much explanation is required by the generality of pupils. There is a sufficient collection and variety of exercises.

We cannot say that either text-book will supersede all other text-books, but each merits, and will no doubt secure a very fair circulation in schools. Mr. Lock's being the fuller, is likely to be the more generally acceptable.

An Elementary Treatise on Conic Sections. By Charles Smith, M.A. (London: Macmillan, 1882.)

A THOROUGHLY excellent elementary treatise. For a long time we have been exercised in mind when asked to recommend a book on Conics. To all its predecessors, with their varying shades of goodness and badness, we had some objection or other to urge. Mr. Smith has just met our want; his book is right up to the time, and is admirably adapted for the preparation of pupils for college scholarships; for students at the university it is a fitting introduction to that as yet unapproached work, Salmon's treatise on these curves. The text is excellent, full in alternative proofs, and suggestive in its methods; the numerous worked-out exercises, in addition to those collected at the close of the several chapters, render the reader independent of any other work. We think the title-page should state that it is an "analytical" treatise on conics.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Darwin Memorial

THE note in NATURE, vol. xxvi. p. 87, on the Darwin memorial, says that there is to be a fund associated with the name of the great naturalist, which shall be devoted to the furtherance of biological science. Probably most biologists would agree that one of the best plans for effecting this object would be one, the idea of which originated with Mr. Sydney Hickson, of Downing College, Cambridge, who is at present on the staff of the Oxford Biological Laboratory. This plan is to establish out of the fund a marine zoological station somewhere on the English coast, that of Devonshire, for example. Mr. Hickson has advocated this course in a letter to the *Times*, where he pointed out that Italy, Austria, and France have zoological stations, while we have none, a fact which is one of the many signs that the teachings of Darwin have aroused more enthusiasm and activity abroad than at home. If you would give publicity to this suggestion it would be certain to come under the notice of the Memorial Committee and of biologists generally. J. T. CUNNINGHAM

Cottons, Romford, May 27

Comet *a* 1882

OWING to recent bad weather, the only opportunity we have had here of observing the spectrum of the comet was on June 4. Unfortunately our view was obstructed by clouds just as it grew dusk, but at 11.30 I managed to obtain a glimpse for a few moments. The nucleus gave a very bright continuous spectrum, with a marked increase of luminosity and widening of the spectrum in the yellow. I could see no lines or bands. I was not able to make any further observations, as the comet was on the point of disappearing behind a tree. A. PERCY SMITH

Temple Observatory, Rugby, June 6

THIS comet was distinctly visible to the naked eye, at 11 p.m. on Sunday, June 4, in the north-west, about 5° to 10° above the horizon (being in a hilly country, I could not estimate it correctly), with a bright nucleus, and a tail about $1\frac{1}{2}°$ in length. The sky had been overcast and stormy all day, but cleared up before midnight. I observed it from a hill-side about 400 feet above sea-level. F. T. MOTT

Leicester

Meteors

ABSENCE from home on business connected with the Transit of Venus Expeditions prevented me sending you earlier notice of a very brilliant meteor, which was seen here and at several distant stations.

On May 4, at 9h. 31m. p.m., Mr. Rooney, one of the assistants of the Observatory, saw a large fire-ball of a light purple tint. It was first observed near the star Arcturus, and then it moved towards the Great Bear, passing between δ and ϵ Ursæ. It burst just under α Ursæ, when its train changed in colour from a purple tint into a brilliant red. It was visible for about five seconds, and lit up the whole garden.

Another assistant, Mr. Cullen, saw the same body from a place not far distant, and his account agreed well with the above.

A note from a friend at Clitheroe informs me that the meteor was seen in that town by several persons, and was as brilliant as the full moon.

Another observer, writing from Prestwich to the *Manchester Examiner and Times*, describes it as having moved from S.S.E. to N.N.W., passing a few degrees to the east of the zenith, and exploding and then vanishing at an angle (altitude) of 40° to 45°.

At Tarporley it was visible for thirty seconds, moving from E. to N.N.W.

The same fire-ball was also seen in Cheshire.

Stonyhurst Observatory, Whalley, May 31 S. J. PERRY

ON May 16, about 11 p.m., I saw a meteor that was, I think, the most terrific, as well as the grandest, I have ever happened to see. I reached my house about ten minutes afterwards, and at once wrote down, substantially, the following unvarnished account of the phenomenon. It may have been witnessed and recorded by some one elsewhere. If so, the observer may like to compare my record of it with his own:—I was walking westward, and I was about two miles south-west of Woodstock (as the crow flies). Suddenly my attention was drawn upward by a brilliant light. I then saw a meteor high up in the western sky, and a little south of the Great Bear. It was descending at an angle of 50°. Its speed was so moderate, that I got a good observation of it. Its seeming size was, I think, quite half that of the full moon. It appearance was such as I never saw before: it struck me as being like a transparent lantern, or, rather, pail, full of burning matter. Its base was a sharply-defined broad cone. It looked as though let down from above by an unseen string, rather than falling. It seemed to be very near me. A flickering reddish flame rose, fitfully, straight up from the horizontal surface of its yellow-hued fiery mass. It vanished, without my seeing any scattering of sparks, when it was about half way between the Pointers and the horizon.

JOHN HOSKYNS-ABRAHALL

Combe Vicarage, near Woodstock, May 27

Earth-Tremors in Japan

AN article on earth-tremors, which appeared in the *Times* last November, seems to have attracted considerable attention in Japan, and a few facts respecting the work which has been attempted in the investigation of microseismic disturbances in this country, may possibly be of interest. In the *Transactions* of the Seismological Society of Japan we have already had three communications on this subject. Prof. H. M. Paul told us how, when searching for a site for the United States Naval Observatory at Washington, by watching the reflection of the image of a star in a vessel of mercury with a telescope, he was easily enabled to detect earth-tremors produced by a railway train at the distance of a mile.

Major H. S. Palmer, R.E., of Hong Kong, gave us an account of how, by digging a trench large enough to contain himself and his instruments when seeking for a station from which to make observations on the Transit of Venus, he practically escaped from earth-tremors which emanated from a railway line about 400 yards distant. As there are strong reasons for believing that many of the earthquakes which are felt in Yedo are produced by the faulting of the rocks, it was natural to assume that before the actual breakage took place there might be a crackling or gradual giving way which would be indicated to us by preceding earth-tremors.

In order to determine the presence of these earth-tremors, at the end of 1879 I commenced a series of experiments with a variety of apparatus, amongst which were microphones and sets of pendulum apparatus, very similar in general arrangement, but, unfortunately, not in refinement of construction, to the arrangements now being used in the Cavendish Laboratory.

The microphones were screwed on to the heads of stakes driven in the ground, at the bottom of boxed-in pits. In order to be certain that the records which these microphones gave were not due to local actions, such as birds or insects, two distinct sets of apparatus were used, one being in the middle of the lawn in the front of my house, and the other in a pit at the back of the house. The sensitiveness of these may be learnt from the fact that if a small pebble was dropped on the grass within six feet of the pit, a distinct sound was heard in the telephone, and a swing produced in the needle of the galvanometer placed in connection with these microphones. A person running or walking in the neighbourhood of the pits, had each of his steps so definitely recorded, that a Japanese neighbour, Mr. Masato, who assisted me in the experiments, caused the swinging needle of his galvanometer to close an electric circuit and ring a bell, which, it is needless to say, would alarm a household. In this contrivance we have a hint as to how earth-tremors may be employed as thief-detectors.

The pendulum apparatus, one of which consisted of a 20 lb. bob of lead at the end of 20 feet of pianoforte wire provided with small galvanometer mirrors, and bifilar suspensions were also used in pairs. With this apparatus a motion of the bob relatively to the earth was magnified 1000 times, that is to say, if the spot of light which was reflected from the mirror moved a distance equal to the thickness of a sixpence, this indicated there had been a relative motion of the bob to the extent of 1000th part of that amount.

The great evil which every one has to contend with in Japan when working with delicate apparatus are the actual earthquakes, which stop or alter the rate of ordinary clocks.

Another evil which had to be contended with was the wind, which shook the house in which my pendulums were supported, and I imagine the ground by the motion of some neighbouring trees. A shower of rain also was not without its effects upon the microphones. After many months of tiresome observation, and eliminating all motions which by any possibility have been produced by local influence, the general result obtained was that there were movements to be detected every day and sometimes many times per day.

Although these observations, which I found required more attention than a private observer was enabled to give to them, have been discontinued, I sincerely hope they may be again taken up. My reason for this is that in a country like Japan, where earthquakes are in some part or other phenomena of everyday occurrence, we have excellent opportunities of determining whether any connection exists between earthquakes and earth-tremors. The idea that earth-tremors may be the forerunners of earthquakes is by no means novel, and that earth-tremors actually exist was demonstrated some years ago in Florence by Timoleo Bartelli, who made microscopic observations of the pointer of a pendulum, which, to free from local surface action, he suspended in a cell. The localities which I should recommend for the observations of earth-tremors would be as near as possible to some earthquake centre. The localisation of these centres, however, is a matter of some difficulty. The difficulty arises from the fact that *good* time observations on earthquakes have, so far as I am aware, never yet been obtained; and farther, although we are able with our seismographs to write down the direction in which the earthquakes shake us backwards and forwards, these directions by no means always tell us the direction in which an earthquake came, an east and west motion having sometimes been proved to have travelled broadside on up from the south.

A great assistance to the interpretation of the various records which an earthquake gives us on our seismographs is what I may call a barricade of post-cards. At the present moment Yedo is barricaded, all the towns around for a distance of one hundred miles being provided with post-cards. Every one of them is posted with a statement of the shocks which have been felt.

For the months of October and November it was found from the records of the post cards that nearly all the shocks came from the north and passed Yedo to the south-west. When coming in contact with a high range of mountains, they were suddenly stopped, as was inferred from the fact that the towns beyond this range did not perceive that an earthquake had occurred. This fact having been obtained, the barricade of post-cards has been extended to towns lying still farther north. The result of this has been that several earthquake origins have, so to speak, been surrounded or coralled, whilst others have been traced as far as the seashore. For the latter shocks earthquake hunting with post-cards has had to cease, and we have solely to rely upon our instruments. Having obtained our earthquake centres, at one or more of these our tremor instruments might be erected, and it would soon be known whether an observation of earth-tremors would tell us about the coming of an earthquake as the cracklings of a bending do about its approaching breakage. To render these experiments more complete, and to determine the existence of a terrain tide, a gravitimeter might be established. I mention this because if terrain tides exist, and they are sufficiently great from a geological point of view, it would seem that they might be more pronounced and therefore easier to measure in a country like Japan, resting in a heated and perhaps plastic bed, than in a country like England, where volcanic activity has so long ceased, and the rocks are, comparatively speaking, 'cold and rigid, if an instrument sufficiently delicate to detect differences in the force of gravity in consequence of our being lifted farther from the centre of the earth every time by the terrain tide as it passed between our feet, could be established in conjunction with the experiments on earth-tremors. JOHN MILNE

Imperial College of Engineering, Tokio, Japan

Limulus

CONCERNING the systematic place of Limulus, I should like to draw attention to a habit which has, as far as I know, never been alluded to in discussions, viz. the manner of casting its skin, mentioned by me in Deformation of Insects (*Mem. Compar. Zoology*). Limulus splits the skin exactly around the front margin of the head. Among Crustacea the Decapods at least split the skin around the hind margin of the carapace. Insects split the skin in the longitudinal middle line of the occiput and thorax, with the later addition of a transversal split on the head. I have seen cast skins of Scorpio, Pseudoscorpions, Hydrachna, and Arachnids, but they are not now at hand for a sure verification. As far as I remember all of them split the skin in the middle line of the anterior parts. At least I do not remember to have seen any transversal anterior split. H. A. HAGEN

Cambridge, Mass.

The Utilisation of Ants in Horticulture

DR. C. J. MACGOWAN has sent me from Han Chow, Province of Hainan, China, a little paper on the "Utilisation of Ants as Insect Destroyers in China." It seems that in many parts of the province of Canton the orange trees are injured by certain worms, and to rid themselves from these pests, the inhabitants import ants from the neighbouring hills. The hill-people throughout the summer and winter find the nests of two species of ants, red and yellow, suspended from the branches of various trees. The "orange ant breeders" are provided with pig or goat bladders baited inside with lard. The orifices of these they apply to the entrance of the bag-like nests, when the ants enter the bladders, and, as Dr. Macgowan expresses it, "become a marketable commodity at the orangeries." The trees are colonised by placing the ants on their upper branches, and bamboo rods are stretched between the different trees, so as to give the ants easy access to the whole orchard. This remedy has been in constant use at least since 1640, and probably dates from a much earlier period. This is certainly a new way of utilising ants, which as a rule are deservedly considered a nuisance by the horticulturist. I should like to learn from any entomological reader of NATURE whether the facts communicated have before been known in Europe, and, if so, whether the species of ant has been determined. C. V. RILEY

Washington, D.C.

Aurora Australis

APRIL 17.—Evening very dark; air close and sultry; thermometer at 65. About 6.35 p.m. noticed a broad sheath of dull osy red in the south, stretching upwards towards the zenith; from outh-east to south was spread a bright greenish-yellow glare, ufficiently luminous to enable us to read the figures of a lady's small watch. Shortly afterwards, the sky from east-by-south to south-south-west was illumined with a ruddy glow deepening to dark red; at the most easterly point of the auroral light were broad pulsating streamers of great brilliancy; these extended to south-east-by-east. Could not detect the slightest sound from aurora. Weather continued fine. April 20.—This evening there was a wide-spread glare of auroral light, with greater range, but of far less brilliancy than marked the grand display on the 17th. Weather fine and clear. T. H. POTTS

Ohinitaki, N.Z., April 21

"Cuprous Chloride Cell"

As the account given of my cuprous chloride cell in your report (NATURE, vol. xxvi. p. 96) of the Proceedings of the Royal Society of Edinburgh is rather misleading, I hope I may be excused if I make a few remarks on the subject. It is there stated that my cells suffered greatly from loss. This is not a correct statement. There are two ways in which the work expended in charging a secondary battery is lost. When a secondary battery is being charged, the E.M.F. between the terminals of the battery is higher than the normal E.M.F. of the battery with open terminals, work being expended in heating the cells. When the charged cells are used to supply a current, the E.M.F. between the terminals is lower than the normal E.M.F. with open terminals, work being again spent in heating the cells. This source of loss is unavoidable, and is in practice very serious. I need only refer to the recent experiments in Paris with Faure accumulators, which were, I think, reported in NATURE. The second source of loss is the local action in the cell. This depends upon the chemistry of the cell. I have found the estimation of loss from this cause a difficult matter, but I think I am justified in saying that the loss from this cause in my cell is very small, when it is properly constructed. In fact, when used as a primary, its advantage is that it does not suffer from diffusion and consequent local action as all double-fluid cells do. I think it deserves a trial as a primary battery on this account. It is necessary to protect the cuprous chloride from air, covering it with water being quite sufficient. If this is done it should be a very durable form of cell A. P. LAURIE

King's College, Cambridge

[The statement that the cells suffered greatly from loss is in our report coupled with an additional statement which implies that other secondary cells have the same fault; so that Mr. Laurie is in no worse predicament than other inventors of secondary batteries. Unless Mr. Laurie's cell is in this respect superior to others, the report can hardly be regarded as misleading.—ED.]

Physico-chemical Lecture Experiments

A VERY striking lecture experiment, which I have never seen performed or described, and which illustrates the reaction, by double elective affinity, of *dry solids*, is the trituration together in a mortar of corrosive sublimate and iodide of potassium. The result is a brilliant scarlet coloration of iodide of mercury. If a large crystal of the one is rubbed on a crystal of the other, a scarlet precipitate (if the word may be so applied) is formed at every point of contact. From the brilliancy of the colour the experiment may be readily seen by a large number of spectators.

June 5 LEIGH CLIFFORD

CUPS AND CIRCLES

AN important addition to the literature of "Cups and Circles" and Cup-marked Stones,[1] has just been issued as part of the fifth volume of "Contributions to North American Ethnology," printed by the Department of the Interior in their series of the publications of the U.S. Geographical and Geological Survey of the Rocky Mountain Region. The literature of the subject as regards the Old World is already extensive, and the object of Mr. Rau's work is to collect and systematise the existing information regarding the "cup and ring cuttings" that have been observed on rocks and boulders in Europe and India, and to add to this systematised knowledge an account of those that are now known in America.

The first monograph on these archaic forms of sculpturings on rocks and stones was that of A. E. Holmberg, on the Lapidary Sculpturings of Scandinavia ("Skandinavien's Hällristningar," Stockholm, 1848), but though copiously illustrated, it remained in a great measure a sealed book, from its being written in Swedish; and it was not till the publication of Mr. Tate's memoir on "The Ancient British Sculptured Rocks of Northumberland and the Eastern Border" (Alnwick, 1865); the exhaustive essay on the same subject by the late Prof. Sir James Y. Simpson, entitled "Archaic Sculpturings of Cups, Circles, &c., upon Stones and Rocks in Scotland, England, and other Countries" (Edinburgh, 1867); and the larger work, prepared under the direction of the late Algernon Duke of Northumberland, entitled "Incised Markings on Stone found in the County of Northumberland, Argyle, and other Places, from Drawings made in the Years 1863 and 1864" (London, 1869) that the attention of archæologists generally was awakened to the

---

[1] "Observations on Cup-shaped and other Lapidarian Sculptures in the Old World, and in America." By Charles Rau. (Washington, 1881.)

subject. Since that time a host of enthusiastic observers has arisen over Europe, and innumerable examples of "cups and circles" have been discovered and described. It is difficult to account for the fascination that allures men to the study and pursuit of these "pitted stones." They are neither beautiful, nor intrinsically valuable. They are often earth-fast boulders, too large for transport, and unsuitable for "collections." But there is an element of mystery about them, and the mysterious is often more attractive than the beautiful or the useful. They pique the curiosity of the ordinary observer by the obvious suggestion that they have a story to tell if they could be made to speak; and they whet the ardour of the scientific investigator by the equally obvious suggestions that they are the products of a definite human purpose, which may be discoverable from an examination and comparison of their special characteristics. Probably no series of archæological remains has been more carefully examined, more minutely described, or more copiously illustrated, and if the accumulation of such a mass of detailed information regarding their typical forms and characteristics over wide areas should ultimately fail in determining the nature of the purpose or purposes for which they were produced it cannot fail to add largely to the extent and precision of our knowledge of an essentially obscure subject.

It is certainly a matter of great interest, whatever may prove to be its general significance, that "cup-stones" and "pitted stones," which are in many cases analogous to those in the Eastern Hemisphere, are found in the United States and other parts of the Western Continent. Perhaps the most remarkakable of those found in the United States is one at Ironton, in Lawrence County, Ohio, which was first brought to the notice of European archæologists by Prof. Daniel Wilson, in the *Proceedings* of the Society of Antiquaries of Scotland for June, 1875. It is a boulder of grey sandstone 3 feet long, 2 feet 7 inches wide, and a foot and a half high, weighing between 1000 and 1200 pounds. The surface of the stone is pitted all over by about 116 cups, whose average diameter is 1½ inches and their depth about ½ inch, and on one side of the block there are several grooves 4 or 5 inches long, shallow and circularly hollowed in the bottom, so that "a cylindrical stone applied in the direction of its length would have produced the grooves, and its end by rotation the cup-shaped cavities." Another cupped boulder of granite occurs at Niantic, in New London County, Connecticut. It has only six cups, varying from about 2 inches to 3⅛ inches diameter, and from ¼ inch to almost 1 inch in depth. Mr. Rau does not notice a still more remarkable boulder of granite in Forsyth County, Georgia, 9 feet long, 4½ feet high, and 3 feet wide, of which Prof. Wilson has given a figure. Along one side of the boulder is a row of cups, eighteen in number, connected by an incised line or gutter, while the face of the boulder is covered with markings of single or double concentric circles, surrounding small cups in the centre. In some cases two of these circles are connected by a straight gutter. Two very large boulders on the bank of the Ohio, a few miles below Manchester, in Adams County, have been seen by Dr. Hill, but are not more precisely described than that they are of sandstone, the one having twenty-nine and the other thirty-seven cups. A large cupped boulder at Orizaba, in Mexico, has been figured in Lord Kingsborough's "Mexican Antiquities." Two boulders of sandstone in an old Indian town in Santa Barbara County, California, are covered with conical-shaped excavations and cup-shaped depressions. The largest is 25 feet long and 10 feet wide, and shows twenty-five excavations from 6 inches to 26 inches diameter at the surface, and 5 to 16 inches deep. In one instance a groove is cut between two of the basins.

"Cup-stones" or "pitted stones" of small size are also frequently found in the United States. The first of these that has been noticed as obtained from the Indian Mounds in Ohio, was described and figured in "The Ancient Mounds of the Mississippi Valley," by Squier and Davis (Washington, 1848), and is now in the Blackmore Museum, Salisbury. It is a small block of sandstone, 6 inches by 8 inches, weighing between thirty and forty pounds, and presenting on its surface three detached cups—two confluent, one half-finished, and several which are apparently just commenced. They are slightly oval in shape, about 1½ inches in greatest diameter, and seven-eighths of an inch in depth. Still smaller stones, often water-rolled greywacke pebbles, with one or more cup-shaped indentations on their flattish sides are extremely common. The cavities are rough and irregular, and the explanation given of their purpose is that they were probably used by the Indians for cracking hickory nuts. Another variety of "cup-stone" with regularly rounded and well-smoothed cups is regarded as paint-mortars. But while some of the larger boulders with basin-like cavities, such as those from Santa Barbara County, California, may have been used as mortars for triturating grain, it is obvious that such an explanation cannot apply to the boulders with smaller cups, or to those cases in which the cups are hollowed in the perpendicular surfaces of stones and rocks.

Such cups, often surrounded by concentric rings, or by broken rings with a gutter passing from the central cup outwards through the part where the rings are interrupted, are found abundantly in the British Islands, and in France, Switzerland, Germany, and Scandinavia. They are sculptured on rocks, boulders, on monolithic and on megalithic monuments, on the stones of dolmens and cists, and on stones built into the walls of underground dwellings. Thus they occur in close connection with the habitations and the graves of prehistoric man in central and north-western Europe. In a few cases in Scandinavia they occur on sepulchral structures that are assigned to the Stone Age, but their associations, so far as these are determinable, are chiefly with the Bronze Age. In Britain, and especially in Scotland, their associations are largely with the Iron Age, and the Age of Bronze; but few, if any well-authenticated instances of their occurrence in association with the typical objects of the Age of Stone are upon record. On the other hand small, portable cupped stones have been found in cists and grave-mounds which are attributed to the Stone and Bronze Ages, both in Great Britain and Ireland. In Brittany the large stones of the dolmens are frequently sculptured with a variety of rude figures, among which cups and circles not unfrequently occur.

Perhaps the most remarkable examples in Scotland are the rock-sculptures at Achnabreac in Argyleshire, described and figured in Prof. Simpson's work, and a rock-surface on the shore of Loch Tay, recently described by Mr. J. Romilly Allen. Prof. Simpson described nearly a hundred examples of rock and stone surfaces thus sculptured, but this number has been more than doubled during the last year by two observers, Mr. William Jolly and Mr. Romilly Allen, the former working in the northern, and the latter in the central, districts of Scotland. In England the most curious examples are those on the moor at Ilkley, in Yorkshire, described in the *Journal* of the British Archæological Association (1879), by Mr. Romilly Allen. In Ireland the most striking groups are those on the stones of the great chambered cairn at New Grange, in the valley of the Boyne, and those associated with the remarkable cairns in the Lough Crew Hills, described by the late Eugene Conwell.

Many theories have been advanced with reference to the presumable purpose of such "cups and circles." It has been suggested that their purpose was useful, that it was ornamental, that it was commemorative, and that it was religious. The utilitarian theory is disposed of by their position in situations where use of any kind is almost impossible. The ornamental theory is negatived by the fact that they occur so often in situations in which they cannot be seen, as for instance on the under sides of cist-covers. The commemorative theory admits of much being said in its favour, but fails to suit all the circumstances of the case. The theory that they fulfilled some purpose in relation to the religious observances of prehistoric man is perhaps the most plausible that has yet been suggested, and has the following arguments in its favour.

If this early system of sculpturing these enigmatic markings on rocks and stones originally had reference to a common idea connected with the religious observances of prehistoric times, the existence of some traces of this connection might reasonably be looked for in the superstitions of the area in which it was formerly prevalent. This, in point of fact, is found to be the case. In many parts of Sweden, these cup-marked boulders are known as *elf-stenar*, and are still believed by the common people to possess curative powers. They say prayers, and make vows at them, anoint the cups with fat (usually hog's lard), place offerings of pins and small copper coins in them, and when they are sick, they make small dolls or images of rags, to be laid in them. These facts are stated in the *Manadsblad* of the Swedish Academy of Science. Miss Mestorf, as quoted by Mr. Rau, is more explicit:—

"The elfs are the souls of the dead; they frequently dwell in or below stones, and stand in various relations to the living. If their quiet is disturbed, or their dwelling-place desecrated, or if due respect is not paid to them, they will revenge themselves by afflicting the perpetrators with diseases or other misfortunes. For this reason, people take care to secure the favour of the 'little ones' by sacrifices, or to pacify them when offended. Their claims are very modest: a little butter or grease, a copper coin, a flower, or ribbon, will satisfy them. If they have inflicted disease, some object worn by the sick person, such as a pin, or button, will reconcile them. A Swedish proprietor of an estate in Uppland, who had caused an elf-stone to be transported to his park, found, a few days afterwards, small sacrificial gifts lying in the cups. In the Stockholm Museum are preserved rag dolls, which had been found upon an elf-stone."

These superstitious practices are connected with actual cup-stones of prehistoric times, but there are others, for the practice of which cups have been made in modern times. In the *Proceedings* of the Berlin Anthropological Society for June, 1875, Dr. Veckenstedt called attention to the existence of cup-markings on the walls of the church of Cottbus, in Brandenburg. Since then, they have been discovered on the walls of churches in more than twenty different localities in Prussia, and also in Germany and Switzerland, and even in Sweden. They are usually on the southern side of the churches, near an entrance, and not beyond the height of a man's arm. According to some accounts, in Germany at least, the cups were believed to possess healing virtues, chiefly for charming away fevers, and in some instances these modern cups in the church walls have been anointed with grease, like the cups in the prehistoric *elf-stenar* of Sweden. In Posen a tradition refers to the cups on the church-walls as the work of damned souls who ground them out in the night-time.

The existence of this superstitious veneration for prehistoric cup-stones, and the continuance of the custom of forming cups (on the walls of Christian churches) for curative purposes, pre-supposes the religious character of the original system of which these twin superstitions are apparently direct survivals. No evidence exists within the area occupied by the prehistoric cup-stones of Europe by which the precise form of the natural religion with which they were connected can be determined. But a religion exists in whose observances cups and circles are still made on rocks and stones. It does not exist in Europe, and there is no direct evidence that it ever existed within the European area, but it exists in the area which was the home of the Aryan race.

In the district of Nagpur, in India, Mr. Rivett-Carnac found a group of grave-mounds surrounded by stone-circles. The mounds contained burials after cremation, accompanied by urns and implements of iron. The circles round the mound are from 20 to 56 feet in diameter, are mostly formed of trap-boulders, but each circle has a few stones larger and more regularly-shaped than the rest, and on these stones he found sculpturings of cups and circles, which he recognises as analogous to the cups and circles of the European area. He has also found in Kumaon, close to the temple of Chandeshwar, a rock-surface, on which, in a space 14 feet by 12 he counted more than 200 cups, varying from an inch and a half to six inches diameter, and from half an inch to an inch in depth. These cups are occasionally surrounded by rings and connected by grooves, but the usual form is that of a simple cup. All these markings, whether on the rocks or on the stones of sepulchral circles, are old, so old that the natives attribute them to the giants. But in the temple itself the conventional symbols of Siva, as Mahadeva (The Generator), were in some cases represented by rough slabs with a cup and circle, or concentric circles with a radiating gutter rudely incised. The resemblance of these symbols to the European cup and ring cuttings is not so close as their resemblance to some of the sculpturings on Bald Friar Rock, on the Lower Susquehana in Maryland. Mere resemblance of form, however important it may be in a tentative classification of things whose relations are unknown, is quite insufficient if not irrelevant as evidence of identity of purpose or significance. Symbols that are absolutely similar in form may have had widely different meanings and applications in different places, at different times. Mr. Rau observes that no one who has examined Mr. Rivett-Carnac's papers in the *Journal* of the Asiatic Society of Bengal (1879) can help admitting the striking resemblance between the cup and ring cuttings of India and Great Britain; and he is probably right in his inference that the close connection between cups and rings implies that both belong to one system of primitive sculpture, the single cup being merely the simpler form. The argument in favour of both forms being symbols of the *cultus* of the reciprocal principles of nature rests solely on the ground of a similarity of form which does not amount to identity. Even though an absolute identity had been established between the ancient and modern sculpturings, their identity of significance would still remain to be proved.

It appears from this extended survey of the phenomena of cup and ring cuttings on rocks and boulders that more progress towards the elucidation of the subject is to be made by the study of their differences and diversities than by the mere observation of general similarities of form and circumstances. It seems probable that there are some, such as the portable varieties, which had a utilitarian purpose. It is not improbable that others of larger size on boulders, such as the block under the entrance to the tumulus of New Grange, may have been merely ornamental; and there are considerations which forbid the absolute exclusion of the supposition that others may have been commemorative, or in some sense possessed of a religious connection and significance. But none of these conclusions can be reached by mere force of argument. If the problem is ever to be solved, its solution will be reached by research, by comparison of the phenomena of different areas, and investigation of the inferences deducible from them. With regard to the American forms, Mr. Rau observes that as the cups on the Cincinnati boulder are perfectly similar to those on many stones in the Old World, it is probable that they owe their origin to the same motives. If these motives arose from some religious conception, we might feel inclined to trace the origin of American cup-cutting to Asia. But if, on the other hand, the cups were designed for a practical purpose, the custom of excavating them may have sprung up in America, as well as elsewhere.

THE ECLIPSE EXPEDITION

THE following letter from its Special Correspondent with the English Eclipse Expedition, appeared in the *Daily News* of Tuesday :—

Sohag, May 19

Still at Sohag! but how different is the place now from what it was when I first sighted it—as it seems, years ago. Then the solitary steamer and the tents of the French party were hardly sufficient to break the shore line as we looked at it, alas for too long a time, from the place of our last *ensablement*. But now the steamer is lost in a fleet of dahabeeahs, and the line of tents and shelters has been extended for some distance towards the town; but tents are coming down, the hot sand is being strewed with boxes, and in 24 hours nothing will be left but some brick piers, which the next high tide will make short work with. Yes, something will be left. Sohag will have taken its place in scientific history by the side of many other out-of-the-world places, which seem to be chiefly affected by eclipses, and its memory may still puzzle the dryasdusts of the future.

As the 17th approached the excitement of almost everybody visibly increased, and as the energy waned the tension waxed. A little wind eddy of fearful violence, which produced a small sand-storm on the land, and almost a waterspout as it tore its way out of sight across the Nile, after hurling down one of the French tents and driving the dahabeeah occupied by the English party from its moorings, was almost a relief; and a further variety was introduced into the monotony of heat and work by the arrival of the dahabeeahs and the final visit of the Governor-General to the astronomers and his new visitors, Aly Pacha Cherif (son of Cherif Pacha, Minister of Mohamet Aly); Osman Pacha Galeb, Governor-General of Assiout; Mahmoud Pacha, director of the Cairo Observatory; Mohamed Bey-el-Kakim, and others being among them. On this occasion the Governor-General Aly Pacha Riza was accompanied by Teidrous Effendi, chief judge, and Mohamet Effendi Kamil, one of the judges of his province, and his aide-de-camp Moustafa Effendi Sirry. The commandant of the garrison of Sohag was also in attendance. Moktah Bey, as usual, acted as interpreter, and the final arrangements for the eventful day were made. First among these the military guard had to be largely strengthened, for not only is a very pardonable curiosity a thing to be utterly suppressed during eclipses, but a whisper had gone abroad that the False Prophet of the Soudan had included the eclipsers in his anathemas, and even one fanatic in the camp at Sohag might give a deal of trouble. And at last the 17th came, ushered in by the finest morning we had had—(clouds had been terribly persistent for several previous days at the time the eclipse was to happen)—and when the observers turned out at dawn to put the final touches to their preparations the local excitement had begun to show itself. On the hill, under palm trees, between us and Sohag there was already a great crowd, which rapidly increased; but a cordon of sentries round the camp kept everything quiet within.

And now for the actual work. In an eclipse there are four critical points: the first, second, third, and fourth contacts, so called—the first when the moon makes its appearance on the sun, the second when its first totality obscures it, the third when the sun again reappears, and the fourth when the sun is quite clear of the moon again. It is of course with the totality—that is, the time that the sun as we know it is invisible between the second and third contacts—that the physical astronomer has almost exclusively to do, but as some of the phenomena are visible slightly before totality the time has to be carefully watched. During totality this has to be done in the most steady manner, and the observer upon whom this duty falls has a most responsible task. In the English Observatory, to which I shall now confine myself, this fell upon Mr. Buchanan; and as the arrangement adopted this time was new, I will describe it. It was devised by Mr. Lockyer as the result of his Indian experience, when the timekeeper found it so difficult to keep the time and to observe the eclipse, which he had come 600 miles to see, that he resolutely turned his back upon the sun lest he should fail in his self-imposed task and so disturb the work of others. What one wants to know at any moment during an eclipse is for how many seconds the phenomenon is yet to be visible and when each ten seconds of the totality have flown away, as each observer has generally more than one thing to do, and the announcement of the timekeeper is the signal for changing his instrument. On this occasion a clock used for testing gas meters was employed, with a seconds pendulum set going at the moment of totality, and with a large dial marked 65, 60, 50, 40, and so on to 0; 65 being the number of seconds which it was thought would leave a safe interval for covering the lenses of all the cameras before the actual termination of the eclipse. The plan answered admirably. Mr. Buchanan sang out the times shown on the dial, and sketched the eclipse with perfect ease.

While the land was darkening and the sky and the Nile were beginning to put on those indescribable hues round which so much of the terror of eclipses is centred, and while the whispers on the hill at Sohag were beginning to surge into a sound—half roar, half moan—some eight minutes before totality, Mr. Lockyer announced the appearance of bright lines, indicating that our atmosphere was already dimly illuminated enough to permit of the atmosphere of the sun being seen through it, and it was easy to see by the rapid pencilling on a copy of Angström's map, which was arranged on a stand under the eye-piece of his spectroscope that observations in earnest had commenced. This went on, the image of the retreating cusp of the sun being carefully kept on the slit of the spectroscope, by Mr. Lawrence until Dr. Schuster, as had been arranged, announced the instant of totality. At this signal Mr. Buchanan said, "65 seconds," Mr. Lockyer left the spectroscope to study the structure of the corona with the telescope, and Dr. Schuster uncovered all the lenses of his camera—all four of them arranged on a single stand—and to all, except the observers, the sun's atmosphere shone out in all its splendour and majesty, and the roar increased on the hill. In the telescope the verdict was that the solar conditions of 1871 were again present; and at the signal "40 seconds more," the information to be gathered by the naked eye and the grating was to be sought by one observer, while the photographic plates had to be changed by another. At this moment the silence in the observatory was broken by shouts calling attention to a strange object among the fainter exterior details of the corona itself, which were more suspected than seen. There, one solar diameter to the right and one solar diameter long, was an exquisitely formed comet, complete with nucleus and tail, sweeping in a beautiful curve, in brilliancy almost, if not quite, equalling that of the very corona itself—a real photometer, in fact, of which we have not yet heard the last. As in the naked eye view there was a struggle with the comet, so with the grating there was a struggle of another kind. A prism or a diffraction grating used without lenses forms what is called a slitless spectroscope. The coronal ring is really used as a circular slit, and according to the substances present in the solar atmosphere we shall have rings or no rings; and if rings are seen, then their presence in certain definite positions will tell us what substances are present. Now, in 1871 rings were seen, and they were very bright. In 1878 no ring whatever was seen. The question to be decided, then, was, Did this year's eclipse resemble in this respect the eclipse of 1871 or 1878? The result of the inquiry was that there were rings, but that they took time to see. This indicated a solar condition more resembling that presented in 1871 than in 1878, but stopping short of it.

Owing to these difficulties, hardly had Mr. Lockyer time to pass back to the telescope by means of which the spectrum of the corona was to be studied, when the clock showed that sixty-five seconds had elapsed, and Mr. Buchanan's "over" filled all with regret that the phenomenon, so rare and beautiful, and full of such precious knowledge, which each was doing his "level best" to secure, should be so ephemeral. So the caps were put on the cameras by Dr. Schuster and his assistant, Mr. Woods, lest the precious records which it was hoped might have been secured should be spoiled by the first beam of the reappearing sun. It turned out, however, that so admirably had the eclipse been calculated, and so exactly had the French party hit upon the central line, that the totality really lasted 7 seconds more, that is, the full 72 seconds. The spectrum of the corona, therefore, was studied for a second or two under, perhaps, better conditions than had ever been present before, excepting during the memorable observation of Janssen in 1871. There were the red and green and blue lines stretching right across a wide field of view, and although no obvious dark lines were seen in the momentary glimpse, it was obvious that the spectrum was not truly a continuous one. There were variations of intensity here and there, and not the equal toning generally observed. So then ended the totality in one of the observatories. Dr. Schuster and his assistants at once proceeded to the extemporised dark room on board the steamer to develop the photographs, while those members of all the parties who had made telescopic or spectroscopic observations retired to the solitude of their tents to write down their results while they were still fresh in their minds.

Later on in the day there was a conference, at which the collective note, which I have already telegraphed to you, was drawn up and signed on behalf of the several expeditions. The observations were thought then, and are thought now, to have been a splendid success. The photographic results obtained by Capt. Abney's rapid plates have secured permanent records of the highest value, which largely increase our knowledge of the sun's atmosphere. They connect the spectrum of the sun with that of the stars in a most unmistakable manner; and, taken in connection with the observations of Lockyer and Trépied on the bright lines visible before totality—observations predicted a year ago in the teeth of received opinion—show that those who would explain solar phenomena in the light of terrestrial chemistry have their work cut out for them. But on this and on some other matters I may have something to say in a subsequent letter.

The Cairo Correspondent of the *Daily News* telegraphs on Monday:—

By order of the British Government, Sir E. Malet has officially thanked the Khedive for the great attention and services rendered to the Eclipse Expedition. The Khedive has returned a complimentary answer. No other Consul has yet thanked his Highness.

AURORÆ IN GREENLAND[1]

SINCE the publication of the researches on Auroræ by Baron Nordenskjöld, the study of this enigmatical phenomenon has acquired still more attraction for the student of the physics of the globe. We are glad, therefore, to notice the appearance of a new work on "Auroræ," published by the Danish Meteorological Institute, being a discussion, by M. Sophus Tromholt, of the fifteen years' observations (1865-1880) made by M. S. Kleinschmidt at Godthaab in Greenland.

The auroræ at Godthaab are seen, of course, almost exclusively in the southern part of the sky. "I do not remember," M. Kleinschmidt says, "to have seen during these last twenty-five years, more than a few times, any aurora in the north; the middle point of the aurora-arc is usually situated between due south and south-south-east, with small oscillations on both sides of this middle point. In all colonised parts of the western coast of Greenland, the auroræ are always seen towards the south; but it seems to me that at the southern extremity of this country, I have observed more intense auroræ extending throughout the whole of the sky." This observation fully confirms the conclusions of Baron Nordenskjöld, as will be seen from his map, which we reproduced (NATURE, vol. xxv. p. 371). Godthaab being situated in 64° 11′ N. lat., that is, in the third region of Nordenskjöld, the exterior circle of the glory must appear as a bow in the south, and the common, or interior one, as a luminous arc in the magnetic north, or, rather, as a light spread throughout the sky. Indeed, northern auroræ were seen at Godthaab only during twenty-five days, out of fifteen years, and their number was but forty in the morning hours, and sixteen in the evening. At Jacobshavn (69° 13′ N. lat.) 50 per cent. of all auroræ are seen towards the south east, 26 per cent. towards the east, and only 9·5 per cent. appear in that part of the sky which is comprised between north-west and north-east. At Upernivik (72° 47′ N. lat.) the disproportion is still greater, 74 per cent. of auroræ appearing between south-east and south, 14·5 towards the east, and only 4·8 per cent. between north and west. As to the frequency of the quiet arc-aurora (the "glory" of Nordenskjöld), as compared with that of the brilliant ray-auroræ, it is difficult to judge by the abstracts of observations published by M. Tromholt, inasmuch as the observer seems not to have attached great importance to this difference; but it results from what he says that the most frequent shape is that of a luminous arc "whose rays are diffused so that the luminous mass seems to be homogenous." The rays are often only pulsations in the arc itself. As to the fascinating and brilliant ray-auroræ, they are by far less frequent than the former; however—in accordance with Nordenskjöld's theory—they are not uncommon in this latitude. The height of the middle point of the arc is usually from 5° to 10° above the horizon. Feeble light, very much like twilight, is not uncommon, as well as a similar light spread throughout the sky. M. Kleinschmidt has also observed auroræ in the shape of "an immense column of smoke," consisting of more or less defined rays: "it nearly always appears in the same position, starting from a point between north-east and east-north-east, whence it crosses the zenith and reaches an opposite point of the horizon." The same was observed in the "common arc" by Nordenskjöld (NATURE, vol. xxv. p. 369, Fig. 5).

The number of auroræ extending beyond the zenith, or appearing in the northern part of the sky being anything but numerous, it is only with caution that we may admit the conclusion arrived at by M. Tromholt as to a periodicity in the oscillations of the "auroral belt;" but it is worthy of notice that his conclusion is the same as that arrived at by Weyprecht, namely, that "the auroral belt advances towards the south about the autumnal equinox, then moves towards the north, and reaches its most northern position about the winter solstice; thence it again moves towards the south, and occupies its most southern position about the spring equinox; after that it again returns towards the north." If confirmed by more extensive observations, this result would imply an

---

[1] "Om Nordlysets Perioder, efter Iakttagelser fra Godthaab i Grönland." Af Sophus Tromholt. (Publication of the Danish Meteorological Institute.) Copenhagen, 1882.

oscillation of Nordenskjöld's "glory" in dependence on the seasons. Another, diurnal oscillation, according to which the auroral belt would slowly advance towards the north (for Godthaab) during the night, seems very probable. It would explain—M. Tromholt says—the greater intensity of auroræ towards midnight, as well as the greater frequency of northern auroræ among those which were observed at Godthaab during the morning; but this last phenomenon, of course, might depend also upon some diurnal variation of the intensity of the "common arc." In any case, these conclusions are to be considered as provisory ones, and must be submitted to the further test of observations carried on at points more favourably situated than Godthaab for the study of these oscillations. Such is also the opinion of M. Tromholt himself.

Of course, the fifteen years' observations at Godthaab do not include a period of time sufficiently long for enabling us to deduce from them the laws of periodicity of auroræ. But still they allow of several interesting conclusions which may serve as a guidance for further researches. Thus, it appears from them—contrary to what was said as to the auroræ being more frequent during the most cloudy days—that the number of observed auroræ is directly proportionate to the brightness of the sky. This dependence appears not only for different years or months, but also for separate days. If all the days when auroræ were observed are classified according to their brightness, which is expressed by the figures 1 to 4, and the brightness compared with the average number of auroræ observed during the days thus classified, we see that while the quantity of clouds was 1·6, 1·7, 1·8, 1·8 ... 3·2, 3·3, 3·4, and 3·5, the average corresponding number of auroræ was 7·0, 7·0, 5·0, 5·0 ... 2·9, 2·7, 3·5, and 1·5, the decrease being altogether very regular, so as to leave little doubt as to the accuracy of the law.

The following data have some bearing on the 11⅑ years' period of auroræ which was deduced from observations in more southern latitudes, and which is considered as depending upon the amount of solar spots. Reckoning the years from August to May, so as to comprise in each year all autumn, winter, and spring auroræ (during the bright nights of the summer they are not observable), the yearly number of auroræ during the years 1865-66 to 1879-80 is given by M. Tromholt as follows:—97, 112, 65, 84, 45, 61, 32, 47, 73, 97, 97, 104, 69, 100, and 75, that is, rather irregular. Nevertheless, it is easy to perceive in these figures a certain periodicity with three maxima corresponding to the years 1866-67, 1876-77, and 1878-79. By introducing a correction which depends upon the brightness of the sky, and reducing the observed number of auroræ to an average cloudiness, M. Tromholt finds another series which is more in accordance with the number of solar spots as given by Wolf. Both series for the years 1865-66 to 1879-80 (August to May), appear as follows:—

Number of auroræ, with correction for brightness of sky

86·2, 91·3, 67·4, 80·9, 51·7, 56·5, 32·0, 46·0, 78·4, 97·0, 95·0, 102·0, 73·0, 85·2, 83·3

Number of solar spots

23·5, 6·1, 18·3, 60·1, 107·0, 133·5, 98·6, 89·4, 51·7, 32·1, 11·6, 13·5, 6·8, 2·2, 16·3

It would seem from these two series, that instead of being proportionate to the number of solar spots, the number of auroræ is rather *inversely* proportionate to this number, the two maxima of auroræ corresponding with the two minima of solar spots, and the minimum of auroræ arriving one year later than the maximum of solar spots. The same appears still better from the observations at Stykkisholm in Iceland, which run through the years 1846-47 to 1872-73. Both curves for this place (auroræ and solar spots), although showing several irregularities, nevertheless display a marked connection between the two phenomena; both inflexions of the auroræ curve towards a maximum correspond very well with the minima of solar spots, and *vice versâ*. The result for Godthaab and Stykkisholm is thus the inverse of what was found in more southern latitudes; and, to explain this contradiction, the author admits that the "auroral belt" is subject in its oscillations to a period of about eleven years, during which it advances more towards the north at the time when the number of solar spots reaches a minimum, and returns back towards the south during the maximum period of solar spots.

As to the number of auroræ observed respectively during the evening and during the morning, the observations at Godthaab fully confirm the fact already noticed at other places, namely, that auroræ are more frequent during evening hours. But it still remains to investigate in how far this difference depends upon the hours of observation, the observer usually taking notice of nearly all auroræ which appear before midnight, and not noticing those which appear during the first six hours after midnight.

Such are the questions discussed in M. Trombolt's memoir. As will be seen, they are rather indicated than definitely solved; but we must be thankful to the author for having raised them, and express a hope that the observations of auroræ which are now made to such an extent in Norway and Greenland, may be extended to the polar parts of Siberia and North America; we earnestly hope that the Meteorological Commission of the Russian Geographical Society, which already has done so much useful work, will soon extend its network of observations over this new field, which becomes every day more and more important.

P. K.

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

VIII.

20. THE MULE DEER (*Cariacus macrotis*).—While the Virginian Deer (*Cariacus virginianus*) is widely distributed all over the continent of North America, it is necessary to go far to the west before we arrive within the limits of the range of the two other species of the same group—the Mule Deer (*C. macrotis*), and the Black-tail (*C. columbianus*). Of these western deer, the latter, of which the Zoological Society had living specimens some years ago,[2] is confined to a narrow strip of land along the Pacific coast. But the Mule Deer has a larger distribution, being found on both sides of the Rocky Mountains, and extending eastwards of the main range, far into the prairies of Missouri.

The Mule Deer was discovered by Lewis and Clarke during their expedition to the Rocky Mountains in 1804, on the Missouri River, in about 42° N.L., and was so named from the excessive development of the ears, which at once distinguishes it from its fellows. Its most natural home is the mountainous region which flanks the main range of North America on both sides, though, as already stated, it extends hundreds of miles into the great plains drained by the Mississippi and its affluents. It is also met with in Oregon and British Columbia, though rather superseded in numbers in this quarter by the Black-tailed Deer.

The antlers of the Mule Deer, which, as in most other deer, are borne only by the male, are of the same peculiar type as those of the Virginian Deer. All the normal tines have a posterior projection, and the beam, after casting off the basal snagg, curves gradually forward and inward, until the extremities remotely approach one another. The tines thus stand mostly upright when the head is carried in its usual position, but when the head

---

[1] Continued from vol. xxv. p. 610.

[2] See Wolf and Sclater "Zoological Sketches," vol. i. pl. 20, for figures of the Deer.

is bowed in battle, the tines become nearly horizontal, and offer formidable weapons of offence. Five points is about the usual number carried by the adult male, though six or seven are not uncommon, and heads are said to have been obtained with even eleven and twelve tines.

FIG. 20.—The Mule Deer.

The size of the Mule Deer is rather larger than that of the Virginian, and it is also more strongly built. Individuals are said to attain a weight of 250 pounds, but this is the extreme size. The most marked characteristic of the species, however, is certainly the long, broad, and thick ears, which are well covered with hair on both sides, and somewhat resemble those of a donkey or mule.

FIG. 21.—The Chilian Deer

For their living examples of this fine animal, Fig. 20 (the first, it is believed, ever received in Europe), the Zoological Society are indebted to one of their Corresponding Members, Dr. John Dean Caton, of Ottawa, Illinois, U.S.A., author of an excellent volume on the Antelope and deer of North America.[1] Males of the species were

---

[1] "The Antelope and Deer of North America," by John Dean Caton, LL.D. New York: Hurd and Houghton, 1877 1 vol. 8vo.

safely imported some years ago, but it is only a few months since that Dr. Caton, after several previous unsuccessful attempts, succeeded in supplementing his gift by transmitting to England an adult female. There is now therefore for the first time some prospect that the Mule Deer may be added to the list of acclimatised species propagating its young in this country.

21. The Chilian Deer (*Furcifer chilensis*).—The Chilian Deer also belongs to the American group of the Cervidæ, but has some special peculiarities, and together with an allied form—the Andean Deer (*Furcifer antisiensis*)—constitutes a small and distinct section of the American Deer, remarkable for the simple character of the bifurcated antlers.

The Chilian Deer is generally known to the natives of Chili as the "Guemul," and, though but slightly deviating from the ordinary deer in general appearance, has been strangely misunderstood by some of the older authors. Molina, in his work on the Natural History of Chili, classed it as a horse (!) under the name *Equus bisulcus*, while Hamilton Smith has referred it to the Llamas, and other authors to the Camels! Gay, in his "Fauna Chilena," published in 1847, first gave a clear account of this animal, and figured the female in the accompanying "Atlas," from a specimen in the Museum of Santiago. Gay tells us it is rare in Chili, being only met with in the Cordilleras of the southern provinces. Mr. E. C. Reed, who sent a skin and skull of the "Huemul" for exhibition before the Zoological Society in 1875,[1] tells us that several specimens of it have of late years been procured by the Chilian vessels engaged in exploring the Chonos Archipelago, and that it extends throughout Patagonia down to Sandy Point, in the Straits of Magellan.

The Chilian Deer is of about the size of a large roedeer, but much stouter and thicker in its limbs. The antlers of the male, as will be seen by the illustration (Fig. 21), are very simple in character, consisting of a well-developed beam provided with a single anterior snag or brow antler, which curves rapidly upwards, and attains nearly an equal length with the beam itself.

FIG. 22.—The Radiated Ground-Cuckoo.

The example of this rare deer in the Zoological Society's collection was received from the Jardin d'Acclimatation of Paris in December last, and is believed to be the only individual of the species ever brought alive to Europe.

22. The Radiated Ground-Cuckoo (*Carpococcyx radiatus*).—To the minds of most people the name cuckoo conveys only the idea of a tree-loving bird of strong flight, that utters a well-known cry and drops its eggs in other birds' nests. But the Cuckoo family (Cuculidæ) of naturalists is an extensive group, containing many birds which not only have neither cuckoo-like call nor parasitic habits, but differ greatly from our familiar summer visitor both in structure and in manner of life. No better instance can be given of this truth than the very remarkable bird which we now figure (Fig. 23) from an example living in the Zoological Society's "Insect House." Though a "cuckoo" in all the essential points of its conformation, it is a purely terrestrial bird with a pair of long and strong legs, and in its general gait and actions much more nearly resembles a pheasant or a rail than the ordinary cuckoo of this country, with which it claims relationship.

The Radiated Ground-Cuckoo was first made known to science in 1832, by Temminck, who described and figured it in one of the *livraisons* of his "Planches Coloriées," published in that year from a specimen in the Leyden Museum. This, he tells us, was received from M. Diard, a well-known Dutch collector, who had obtained it at the settlement of Pontianak, in Western Borneo. A ticket attached to the foot of the bird called attention to its singular structure and habits, and contained the remark that it differs from the Malkoha Cuckoos (*Phænicophai*) also found in the same district, in keeping constantly on the ground in search of worms, and in avoiding danger by rapid running, whereas the Malkohas are always met with flying about amongst the trees in search of insects.

---

[1] See *Proc. Zool. Soc.*, 1875, p. 44.

Our great countryman, Mr. Wallace, who, we believe, met with this ground-cuckoo in Sarawak, also speaks of its terrestrial habits, and states that its mode of life resembles that of the pheasants of the genus *Euplocamus*. Little else appears to have been recorded respecting this cuckoo, which is certainly one of the most peculiar forms of bird-life that have of late years been exhibited in the Zoological Society's aviaries.

On examining the specimen in question, which, when it first arrived, had only a half-grown tail, but is now in excellent plumage, it will be at once observed that the naked space round the eye has been incorrectly coloured in Temminck's figure of this species. Instead of being of a red colour as there represented, it is of a nearly uniform pale green, as is likewise the bill. Few non-professional ornithologists, indeed, would recognise a cuckoo in the pheasant-like ground-loving bird with large bright bill, which is labelled in the Zoological Society's Gardens "The Radiated Ground-Cuckoo."

MR. STROH'S VIBRATORY EXPERIMENTS

A CENTRE of attraction at the recent Paris Electrical Exhibition was the Norwegian section, in which Prof. Bjerknes of Christiania exhibited his remarkable experiments with little drums or tambours vibrating under water, and attracting or repelling each other according as the phase of the pulsations was like or unlike. An account of his results was published in NATURE, vol. xxiv. p. 361, and the analogy between them and the well-known effects of magnetism was there drawn attention to. The field opened up by Prof. Bjerknes has been entered by Mr. Augustus Stroh, a well-known member of the Society of Telegraph Engineers and of Electricians, who recently delivered a lecture on his researches. Mr. Stroh has gone over the experiments of Dr. Bjerknes in air as a medium for propagating the pulsations of the drums instead of water, and has advanced beyond his predecessor in further experiments on the same line. The beauty of the apparatus and methods devised by him, and the exquisite skill with which he manipulated them, elicited the unanimous admiration of his hearers.

The drums employed by Mr. Stroh were small shells of wood having their mouths covered by an elastic membrane and their rears communicating with a flexible pipe, through which the pulsating air was communicated to the membrane, so that it could cause the latter to bulge out or collapse at every wave of air. The source of the vibrations was a vibrating reed, against which the air was forced by a small hand-bellows shaped like an accordion. By employing a flexible forked tube with arms of equal length, each fitted with a drum at the end, the vibratory air-blast from the reed could be conveyed to the drums so as to set them vibrating in like phase; and when one of the drums was mounted on a vertical axis, and free to rotate round it like the pole of a balanced magnetic needle, the approach of the other drum to it resulted in an attraction between them which was very pronounced. In this case the drums were vibrating in like phase, that is to say, they both bulged out and bulged in simultaneously. The mechanical explanation of the attraction is that there is a rarefaction of the air between the drums produced by the simultaneous advance and recession of the membranes toward each other. This rarefaction occasions a difference of pressure between the front and backs of the drums, causing them to move towards each other.

When, however, the vibrations are in opposite phase, that is to say, when one drum bulges out while the other bulges in, there is a repulsion between the drums corresponding to a condensation of air in the space between them. This condition of things is ingeniously obtained by means of an electromagnetic air-pump or bellows devised by Mr. Stroh. It consists of an iron armature placed between the poles of two double electromagnets, and free to move alternately towards either electromagnet. This to-and-fro motion of the armature is kept up by making and breaking the battery circuit in the coils of the electromagnets alternately. The armature carries a cross-arm or lever-rod fixed at right angles to its axis, and the ends of the rod are attached to two leather diaphragms, which act as partitions across the interior of two boxes. Each of these two boxes communicates with the external air by two pipes or orifices, one on each side of the leather partition. Now when this diaphragm or partition stretching across the box oscillates, air is expelled from one compartment of the box, and at the same time air rushes into the other through the orifices provided. It follows that if the orifices communicate with two drums one drum will collapse whilst the other is inflated. Now the oscillations of the armature keep the diaphragm oscillating, and hence the two drums communicating with opposite compartments of the air-chamber are kept vibrating in unlike phase. By employing two such air-boxes or pumps Mr. Stroh is able at a moment's notice to change the vibrations of the two drums from like to opposite phase by simply connecting the drums to the two expelling compartments of the two boxes, or one to an expelling and the other to an indrawing compartment of the box. The same device of a pivoted drum served in this case also to show that when the drums were vibrating in unlike phase there was repulsion between them.

In the science of magnetism we are taught that like poles repel and unlike poles attract; but in the experiments we are considering it is the drums in like phase which attract and those in unlike phase which repel. Mr. Stroh does not attempt to theorise upon his results; but if the analogy with magnetism hold good our ideas of what constitute like poles in a magnet will suffer a considerable change.

The aërial analogy for the attraction which always takes place between a piece of soft iron and a magnetic pole, whether it be a north or a south pole, was illustrated by Mr. Stroh in holding quiescent or non-vibrating bodies, such as his hand, or a piece of cardboard, near to either drum. The result was always an attraction of the drum towards the passive surface presented, whatever the phase of the drum. This attraction was prettily shown by means of a small round disk of paper attached to the end of a delicate lever pivoted on an upright stand like a magnetic needle.

The dying oscillations of the pole of a magnetic needle, when brought to rest in front of a disturbing magnet, were further illustrated by Mr. Stroh, in presenting the free drum a little apart from the pivoted one, and observing the latter shift round and oscillate before the other, until it came to rest face to face with it. This of course happened when the two drums were vibrating in like phase. When they vibrated in opposite phase, the pivoted drum moved away from the free one, and came to rest further off.

Until this point Mr. Stroh had been occupied with repeating Dr. Bjerknes' experiments in air; but beyond this he makes a new departure on his own account. The object of his further experiments was to ascertain what goes on in the air between the vibrating drums; and by inclosing a pair of the drums in an air chamber communicating with a capillary tube containing a column of spirits of wine to act on a pressure guage he showed that when the vibrations were of like phase, the spirit fell, indicating that the air was expelled from between the drums, and on the contrary, when the vibrations were of unlike phase, the spirit rose in the tube, indicating that air had been drawn into the space between the drums, and the pressure thereby raised.

The most valuable part of Mr. Stroh's results was now arrived at. By a series of test experiments he demonstrated that the lines of pressure in the air between the two drums are practically identical in direction with those which Faraday revealed to us in the magnetic field by means of iron filings. These were investigated by exploring the field between the drums with a small taper flame and noting the direction of the blast, as well as with a small windmill mounted on a stand, but the action of both these explorers requires a still atmosphere, and therefore could not be shown to a large audience. Mr. Stroh however, had devised a means of showing the movements of the air by models of the drums vibrating in glycerine traversed by the electric light which threw an image of the drums upon a screen. The membranes of the drums were oscillated in this case by working a crank and pulley, and four star-like water-wheels were pivoted between them in such a manner that when the drums were vibrated the wheels revolved under the streaming of the glycerine caused by the vibrations of the drums. Aniline blue placed in the glycerine at the middle of the surfaces of the drums also indicates the stream lines of the fluid to an audience. Starting from the middle, the glycerine separating into two trails, curved outwards into a kind of volute. This happened at both membranes, so that the space between was filled up by four such curves having a diamond space between them. This effect was produced by unlike phase, and closely resembled the arrangement of lines seen when two like magnetic poles are opposed to each other. On the other hand, the stream lines produced by vibrations in like phase were much less complex, and resembled the lines of force crossing over between two unlike magnetic poles.

NOTES

AT a meeting of the subscribers to the Memorial to the late Prof. Rolleston, held at the Royal College of Physicians on Thursday, June 1 last, it was resolved that the fund subscribed for the above object, which amounts to a little over 1100*l*., should be paid to the University of Oxford, as trustees, for the purpose of founding a prize, to be known as the Rolleston Prize, to be awarded every two years to the author of the best memoir embodying the results of original research on any branch of the following subjects:—Animal and Vegetable Morphology, Physiology and Pathology, and Anthropology. The prize, which will amount to about 70*l*. on each occasion, is to be open to all members of the Universities of Oxford and Cambridge who have not exceeded in standing ten years from the date of their matriculation. The adoption of the report of the executive committee was moved by Prof. Acland. Sir James Paget, Mr. Douglas Galton, and other distinguished men of science were present. A vote of thanks to the chairman, Dr. A. B. Shepherd, who has been most active in the furtherance of the objects of the Memorial, and also to the secretaries, Messrs. W. M. Moullin, M.D., C. T. Acland, M.A., A. P. Thomas, M.A., and E. B. Poulton, M.A., was carried.

CAPT. DOUGLAS GALTON, R.E., C.B., F.R.S., has accepted the Presidentship of the forthcoming Congress at Newcastle of the Sanitary Institute of Great Britain.

M. DUMAS, Perpetual Secretary of the Academy of Sciences, Paris, has, we understand, requested Dr. Siemens to allow a translation of his paper on the Conservation of Solar Energy to appear under M. Dumas' authority in the *Annales de Chimie et Physique*.

THE Committee for the arrangement of the Electric Exhibition in Vienna have resolved to delay the opening of the Exhibition till 1883.

THE fifth annual meeting of the Midland Union of Natural History Societies takes place at Nottingham on June 15. The programme includes a *conversazione* on the 15th and various excursions on the 16th.

THE Jubilee Exhibition of the Royal Cornwall Polytechnic Society and the Fine and Industrial Arts, will be opened at the Polytechnic Hall, Falmouth, on Tuesday, September 5, 1882. The Exhibition will be on an extensive scale, and the Committee have determined to make it representative of the progress of the past half century in science and art, mining enterprise, naval architecture, and fishing, meteorology, photography, natural history, and statistics, as well as the fine arts pure and applied, more especially in connection with the county of Cornwall. The Exhibition will be attended by men eminent in science, who will come to Falmouth after the British Association Meeting at Southampton, several of whom will deliver lectures at the jubilee. Electricity and the electric light will be a special feature of the Exhibition. The Exhibition itself will occupy the Polytechnic Hall and the Volunteer Drill Hall, and will be open for double the ordinary period. Excursions on a large scale will also be organised for exploring the sea coast, the scientific and archæological interests, and the natural beauties of the neighbourhood. In order to ensure success the Committee with confidence solicit the aid of all Cornishmen. They estimate that 600*l*. will be required to carry out the object in view.

A YOUNG Finnish lady, Miss Irene Åström, passed the examination for a candidate of philosophy at the University of Helsingfors, on May 24, with great honours. The young lady was subsequently, through a deputation of ladies, presented with a gold watch and chain, at a festive meeting given in her honour at the Æsthetic Club, Hesperia.

AT the expense of Herr Oscar Dickson, of Gothenburg, a promising young Swedish entomologist, Herr A. S. Mortenson, will, during the summer, study the entomology of the islands of Gotland and Öland in the Baltic.

IT ought to be mentioned, to the credit of our namesake, *Naturen*, that its recent numbers contain an unusually large proportion of original matter of more than local interest. To the April number, Hr. J. B. Barth, Director of Forests, has contributed an exhaustive and highly interesting memoir on forest economy generally, and on the biology of the Norwegian pine, *Abies excelsa*, specially. He treats at great length of the physical influence exerted by this tree, in rendering the earth around it more adaptable for its own rapid diffusion, as well as for that of other plants, and he regards it as of later development than the common fir, *Pinus sylvestris*, which, it appears, it is destined to some extent to supersede. The same number contains an amusing, but not uninstructive paper by Hr. Uhrbrand, on the appearance of will-o'-the-wisps (Norw. *Lygtemænd*) and their chemical or meteorological character, and a short notice by Hr. Reusch, of the conglomerates near Christiania. The May number gives a summary of Vogt's recent reports of the mines and minerals of Norway, from which it would appear, that while no sanguine hopes can be entertained of the continued yields of the once prolific Norwegian silver mines, the newly opened copper, nickel, and apatite works promise to become the most remunerative of the otherwise unimportant sources of national industry. The same number records the most interesting results of Hr. Tromholt's comparisons of the various meteorological observations made in Greenland, chiefly by officers of the Danish navy. From these it is shown, that while the auroral manifestations exhibit in Greenland the same periodicity of intensity as elsewhere, their minima and maxima do not correspond with those of the solar spots, the minima of the aurora coinciding with the maxima of the spots, and *vice versâ*. It also appears, that the arch of the aurora is most frequently seen at the south of the magnetic pole, and only in exceptional cases in the north, and that mostly at the winter solstice, when the southern manifestations generally are of rare occurrence, their greatest frequency coinciding with the equinoxes.

THE tide of travel, with insects, as with men, seems naturally to be from east to west. With the noted exception of the grape phylloxera and the Colorado potato beetle (as Miss Murthly points out in a paper to the St. Louis Academy), Europe has not received from America any considerable pest, while innumerable noxious species have crossed the Atlantic from Europe. There is a comparative scarcity, too, of Asiatic insect species on the western seaboard of America, notwithstanding frequent ocean traffic. Spite of great arid plains and lofty mountains, nearly all the insects of Eastern American States, including those from Europe, have found their way to the fields, orchards, and vineyards of the Pacific States. One of the latest insect-invaders from Europe is the cabbage or rape-butterfly (*Pieris rapæ*, Schrank). It appeared about twelve years ago in some northern seaports, and its range now extends from far north in Canada to the south of Georgia. It attacks every cruciferous garden vegetable, but in the flower garden curiously rejects plants of that family in favour of mignonette. Miss Murthly has noted a large amount of premature emergence from the chrysalis, and consequent death; indicating imperfect adjustment of the insect to the climate of its new habitat. In Europe the insect is mainly kept in check by numerous parasites. For several years in America none such came to the aid of the disheartened gardener, but some have now appeared, the most important being a small, metallic green fly, which, though identical with the most destructive European parasite, is proved to be indigenous on both sides of the Atlantic. It lays its eggs in or upon the skin of the mature caterpillar, and from these come small maggots, which live on the fatty tissues of their victim, but do not touch its vital organs till the chrysalis state is reached.

THE mines opened a short time since in China in the province of Chihli, with the special support and patronage of Li Hung Chang, have recently become the subject of much adventitious interest in Europe. The working of these mines was wholly a native enterprise; foreign machinery was imported in large quantities, and up to a month or two ago all seemed going on well. A canal between the mines and Tientsin was nearly completed, and it was calculated that 250 tons of fine coal could be forwarded daily to the latter port. Five thousand tons were, it was said, ready at the pit's mouth for conveyance as soon as the canal was opened. It was believed that, with sufficient transport, one thousand tons a day could be raised for many years from the present pits, while it was said that fifty collieries of an equal size to the present one could be opened in or near Kaiping. The information, therefore, telegraphed by Reuter's agent in Shanghai that the further working of the mines had been peremptorily stopped by the Government, came with a shock to many interested in progress in China. It was stated that a censor in a memorial to the throne complained that the long galleries in the mines, and the smoke of the foreign machinery, disturbed the earth dragon, who in his turn disturbed the spirit of the Empress, who died some months ago, and who was buried about a hundred miles off. The irate spirit of the departed lady promptly took vengeance by afflicting the denizens of the palace in Peking with measles. The latter were, the censor is reported to have said, distinctly traceable to the Kaiping mines, which interfered with the *fêng-shui*. The conclusion was obvious: the mines must be stopped. Such was the story told by the Tientsin correspondent of a Shanghai newspaper. The process by which a suggestion that the mines should be stopped grew in the excited minds of the residents of Shanghai into the certainty that they were actually stopped—and thus to Reuter's telegram—is not an unfamiliar one. The latest information from the East enables us to say that the mines are still working as usual, and there is not the slightest evidence that there is or has been any intention of interfering with them. It is even denied that such a memorial as that mentioned above has had any existence except in the imagination of a *gobemouche* at Tientsin. However this may be, it must be confessed that the petition has a Chinese ring about it, and that the method of argument is one sufficiently familiar to readers of the *Peking Gazette*. The mines are fortunately within Li Hung Chang's jurisdiction, and while they enjoy his encouragement it is unlikely that *fêng-shui* or other superstition will be allowed to interfere with them.

THE Chinese Customs authorities have, we observed, declined to assist the Chamber of Commerce of Shanghai in making a series of meteorological observations along the coast of China. We have already described the project in these columns. The reason of this refusal is unknown; but it is generally believed that Sir Robert Hart, the Inspector-General of Chinese Customs, intends establishing a special meteorological bureau in connection with his department. If Sir Robert can obtain the assistance of one of the very few men in the East competent for such a task, he may add one more to the many good services which the organisation over which he presides has done to China.

A SHARP earthquake shock, at first undulatory, then vertical, lasting seven seconds, was felt at Naples on Tuesday Morning at 6·47. The instruments on Mount Vesuvius gave warning. The centre of the disturbance proves to have been at Isernia, in the Abruzzi, according to the telegrams received since.

A *conversazione* in connection with the Royal Colonial Institute will be held at the South Kensington Museum on the evening of June 23.

THE Scientific Publishing Company announce that they have in the press "Photometry and Gas Analysis," by J. T. Brown, F.C.S., divided into three sections—Standards, in two chapters, Photometers, in eight chapters, and Gas Analysis, in two chapters. The Company also announce the publishing in handy form of the "Minutes of Evidence on Electric Lighting Bill, 1882," with text of the bill and a commentary upon the whole.

WE have received a sensible and interesting lecture on the Relations of Science to Modern Life, by the Rev. Dr. H. C. Potter, delivered before the New York Academy of Sciences; it is published by Putnam and Sons of New York.

WE have on our table the following books:—British Freshwater Algæ, II., Mr. C. Cooke (Williams and Norgate); Transactions of the Brighton Health Congress (J. Beal and Co., Brighton); Capital and Population, Fredk. B. Hawley (Appleton, New York); Hydrographical Surveying, Capt. W. G. L. Wharton (Murray); Logic for Children, A. J. Ellis, F.R.S. (C F. Hodgson); First Lessons in Geology, A. S. Packard (Providence, U.S.); Diagrams to First Lessons in Geology, A. S. Packard (Providence, U.S.); Anales de la Officina Meteorologica, vol. ii., B. A. Gould (Buenos Aires); Scientific Transactions of the Royal Dublin Society, vol. ii. series ii.; The Great Diamond Fields of the World, Edw. W. Streeter (Bell and Sons); A Flight to Mexico, J. J. Aubertin (Kegan Paul); Geological Survey of Canada, Report of Progress for 1879–80 (Dawson Brothers, Montreal); New Indian Lepidopterous Insects, F. Moore (Asiatic Society); Regenwaarkemingen in Nederlandsch Indie, 1881 (Batavia); Lohrmann's Mondcharten, J. A. Barth of Leipzig; The Land of the Bey, T. Wemyss Reid (Low and Co.); Catalogue of Fossil Foraminifera in the British Museum; Die Seefischerei an der Westkisten Schwedens, Gerhards. Yhlen (Norstedt und Soner, Stockholm); Botanicon Sinicum, E. Bretschneider (M. D. Trubner and Co.); Tabular View of the Geological Systems, Dr. Clement (Swan Sonnenschein); Report on Injurious Insects, E. A. Omerod (Swan Sonnenschein); Bibliographie Generale de l'Astronomie, vol. ii. (Brussels); Proceedings American Association, 2 parts; Colliery Ventilation, Alan Bagot (Kegan Paul); Report U.S. Geographical Surveys, vol. vii. Archæology (Washington); Report of the Metropolitan Board of Works, 1881; Botanical Atlas, parts 1 and 2, D. M'Alpine (W. and A. K. Johnston); Ancient Water Lines, D. Milne Home (Edinburgh, Douglas); Laboratory Guide, A. H. Church (Van Voorst); Wolf's Naturwissenschaftlich-Mathematisches Vade-Mecum; Madeira, its Scenery and how to see it, Ellen M. Taylor (Stanford); The Foundations of Mechanics, W. F. Browne (Griffin and Co.); Land Nationalisation, A. R. Wallace (Trübner and Co.).

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Capt. E. B. Stephens, R.N.; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Miss R. M. Stanley; two Striped Hyænas (*Hyæna striata*) from India, presented by Mr. N. H. Beyts; a Cape Zorilla (*Ictonyx zorilla*) from Cape Colony, presented by Capt. Farmer, s.s. *Pretoria*; a Three-striped Paradoxure (*Paradoxurus trivirgatus*) from India, presented by Mr. R. A. Sterndale; a Puma (*Felis concolor*) from America, presented by Capt. J. Jellicoe, R.M. s.s. *Moselle*; an American Tantalus (*Tantalus loculator*) from Columbia, presented by Mr. H. B. Whitmarsh, R.M. s.s. *Moselle*; a Java Sparrow (*Padda oryzivora*) from Java, presented by Miss M. North; a Landrail (*Crex pratensis*), British, presented by Mr. A. Battiscombe; a White Pelican (*Pelecanus onocrotalus*) from North Africa, presented by Mr. C. G. Bolau; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, an Emu (*Dromæus novæhollandiæ*) from Australia, four Summer Ducks (*Aix sponsa*) from North America, three Brant Geese (*Bernicla brenta*), two Common Wigeons (*Mareca penelope*), a Common Buzzard (*Buteo vulgaris*), European, deposited; two Great Anteaters (*Myrmecophaga jubata*) from South America, a Negro Tamarin (*Midas ursulus*) from Guiana, a Purple Heron (*Ardea purpurea*) from Java, a Blue-crowned Hanging Parrakeet (*Loriculus galgulus*) from Malacca, two Rose-breasted Grosbeaks (*Hedymeles ludovicianus*) from North America, a Bell's Cinixys (*Cinixys belliana*) from Angola, purchased; a Red Deer (*Cervus elaphus*), born in the Gardens; two Herring Gulls (*Larus argentatus*), two Impeyan Pheasants (*Lophophorus impeyanus*), four Horned Tragopans (*Ceriornis satyra*), two Peacock Pheasants (*Polyplectron chinquis*), bred in the Gardens. The following species of insects have emerged in the Insect House during the past week—Silk Moths: *Actias selene*, *Attacus mylitta*, *Attacus cynthia*, *Telea polyphemus*; Butterflies: *Limenitis sibylla*, *Argynnis paphia*, *Lycæna iolas*; Moths: *Chærocampa elpenor*, *Sphinx pinastri*, *Sesia spheciformis*, *Sciapteron tabaniforme*, *Callimorpha dominula*.

OUR ASTRONOMICAL COLUMN

THE COMET (1882 *a*).—In a circular issued from Lord Crawford's Observatory on May 29, Dr. Copeland remarks that the spectrum of the nucleus of the present comet deserved the closest attention, as it showed "a sharp bright line coincident with D, as well as strong traces of other bright lines, resembling in appearance those seen in the spectra of γ Cassiopeiæ and allied stars." For some weeks the head had exhibited white light, which might be inherent in the comet or the reflected light of the sun; on May 28 the nucleus began to throw out yellow rays, which on June 1 were also given out by parts of the tail immediately behind the head. Of γ Cassiopeiæ, Secchi writing in 1877, says: "Le plus remarquable de ces étoiles exceptionelles est γ de Cassiopée, qui présente les raies spectrales de l'hydrogène, non pas noires, par renversement, mais directement brillantes, curiosité unique jusqu'ici dans tout le ciel. Il n'y a que β de la Lyre qui ait quelquefois les raies brillantes, et encore pas toujours, parce qu'elle est variable"; and he further writes of β Lyræ, "Elle nous a montré une fois, au maximum d'éclat, les raies brillantes de l'hydrogène, comme γ de Cassiopée, chose que nous n'avons plus vue ensuite, bien que nous l'ayons souvent cherchée."

The Radcliffe meridian observation of the comet on May 20, communicated by Mr. Stone last week, shows that the place calculated from the orbit we then published required only the following small corrections:—$\Delta\alpha . \cos\delta = -1''·8$ $\Delta\delta = +4''·0$.

The Kiel observation on May 31 indicates corrections of +4″ in R.A., and −19″ in declination.

The positions given last week for June 10 and 11 are not likely to require material correction. In seeking for the comet in daylight on those dates, care should be taken to focus accurately (for this purpose Mercury or Venus may be available), and a pretty long "dew-cap" or a cardboard tube should be fitted to take off the direct sunlight from the object-glass. At so short a distance from the sun, it will of course be necessary to use a dark glass, but it may be well that the illumination of the field should not be diminished much beyond that which the eye will readily bear. More than one astronomer considered he had missed seeing the first comet of 1847 in daylight on March 30, by using too dark a glass; this was the opinion of Dawes, who could not otherwise explain his want of success.

On August 9 the comet situated near the star 16 Virginis will have the same theoretical intensity of light as at the first Harvard College observations on March 19, setting in London about 1h. 50m. after the sun. On July 5, when not far from Regulus, the intensity of light is equal to that on May 6.

THE TRANSIT OF MERCURY, 1881, NOVEMBER 8.—This phenomenon was fully observed at Sydney, by Mr. H. C. Russell and seven assistants. The mean results are as follows, in Sydney, M.T.:—

	h.	m.	s.	
First contact—external	8	21	57·53	a.m.
,, —internal	8	23	40·65	a.m.
Last contact—internal	1	40	25·16	p.m.
,, —external	1	42	9·22	p.m.

If we calculate with Leverrier's Tables of the Sun and Mercury, and adopt his diameters, the above observations show differences for the internal contacts of +22·9s. and +26·2s. respectively.

THE SMALL PLANETS.—The number of known members in this group is now 225, the last one having been discovered by Palisa at Vienna on April 19. It appears to belong to the more distant division of the group, the period of revolution exceeding six years.

THE CORDOBA ZONES.—We have received vol. ii. of "Resultados del Observatorio Nacional Argentino en Córdoba," containing the observations of stars in zones, made during the year 1872, and shall give an early account of this important work, for which astronomy is indebted to Dr. Gould's untiring energy and zeal, and the enlightened liberality of the Argentine Government in promoting the interests of science.

CHEMICAL NOTES

IN the Chemical Section of the Meeting of Bohemian Naturalists in Prague, on May 27, B. Brauner (Fellow of The Owens College) communicated a paper on the atomic weight of didymium. The author's former determinations gave the number 146·6, but after further purification he finds now didymium to be 145·4. Both samples were entirely free from any known earth metal. Assuming that both numbers are true, the author remarks that the only explanation which can be given, is that "didymium" is a mixture of two (or more) bodies, one, whose atomic weight is *smaller* than 145·4, and a second, whose atomic weight is greater than 146·6. Thus it is clear that the chemistry of didymium becomes as complicated as that of "erbium," which was thought to be a simple earth, and later on was split up into the following earths, viz. real (1) erbia, (2) terbia, (3) scandia, (4) ytterbia, (4) thullia, and (6) holmia. The evidence, that the mineral cerite contains other earth metals besides cerium, lanthanum, and didymium, has been given by the author some time ago (*Monatshefte* iii. 1) when he found that the *spark-spectrum* of the portions *intermediate* between lanthanum and didymium, as well as of those between didymium and cerium, contains *new lines*, not belonging to any known cerite metal. The author is pursuing his researches in the laboratories of the Owens College.

ZIMMERMAN, who recently determined the densities of gaseous uranium tetrachloride, and bromide, has obtained pure metallic uranium, and made measurements of its specific heat, which completely confirm the number 240 as the atomic weight of this metal (*Berichte*, 15, 847).

J. W. Brühl, from the results of determinations of molecular refractions of many carbon compounds, concluded that the atomic refraction of carbon varies according as the atoms of carbon are tetravalent, divalent, or monovalent (singly, doubly, or trebly "linked"), in the molecule under consideration. In calculating molecular refractions, Brühl used the empirical expression $\frac{n - 1}{d} \cdot M$; Landolt has recently re-calculated the ratios of many molecular refractions by the use of the formula $\frac{n^2 - 1}{(n^2 + 2)d} \cdot M$, deduced by Lorenz from the theory of light; his results entirely confirm those arrived at by Brühl by the use of the empirical expression stated above

In their researches on ozone, MM. Chappuis and Hautefeuille have made use of the spectroscope to trace the progress of the chemical change which occurs when oxygen, or a mixture of oxygen and nitrogen, is subjected to the action of the electric discharge. They find that ozone is characterised by a distinct absorptive spectrum, the prominent bands in which are two in number situated in the neighbourhood of D. The same bands are promineut in the absorptive spectrum of liquid ozone.

MM. Chappuis and Hautefeuille also find that the amount of ozoue produced by the action of the electric discharge on a mixture of oxygen and nitrogen increases to a maximum, then decreases to a minimum, then again increases, and so on; by the aid of the spectroscopic method they trace this oscillation to the formation and decomposition of an oxide of nitrogen not hitherto observed, which they propose to call pernitric oxide (*acide pernitrique*) (*Compt. rend.*, xciv. 858 and 1111).

The *Journal* of the Society of Chemical Industry, the fourth number of which is now before us, promises to be of very great service to all who are interested in chemical manufactures. The present number of the journal contains papers read before the Society on "Smoke Abatement," "The Chemical Technology of Jute Fibre," "The loss of Sulphuric Acid in the Manufacture of Salt Cake," &c. Notes on the more important recent technical applications of chemistry and chemical physics, and very useful classified abstracts of recent patents complete the number.

In the last number of the *Berichte* of the German Chemical Society (xv. 1161) HH. v. Meyer and H. Goldschmidt describe an apparatus by means of which the specific gravities of gases may be determined at very high temperatures. The apparatus consists of a cylindrical porcelain tube 500 or 600 mm. in length, capacity about 100 c.c., furnished with a capillary tube of about 200 c.c. long at each end. The apparatus is heated, the air is driven out by an inert gas, *e.g.* by nitrogen, the gas whose specific gravity is required is allowed to enter the apparatus, and the weight of this gas is determined by driving it out, by means of an inert gas, into some liquid by which it is completely absorbed. The temperature may be calculated from the ratio between the volume of air contained in the apparatus under the conditions of the experiment and the volume contained at the ordinary temperature of the room. By the use of this apparatus the authors have determined that the density of cyanogen is normal (*i.e.* corresponds with the formula C_2N_2) between 100° and 800°, but that at 1200° this gas is decomposed with evolution of nitrogen.

PHYSICAL NOTES

A new method of comparing the brightness of different coloured lights has been proposed by Herr Brücke (*Wien. Ber.*, 84). He finds that objects cease to be visible at a greater visual angle, the more they differ from the background on which they are seen, only in colour and not in brightness. If a board be set up, which is black at one end and white at the other, with successive shades of grey between (a brightness-table), one may determine the brightness, *e.g.* of a coloured paper, by placing a piece of it before different parts of the board, and noting the place where, with shortest interval, it becomes invisible. This relation of brightness, in red and blue, varies much with the strength of illumination, so that each determination becomes invalid, where the illumination is considerably altered. Herr Brücke believes such a table might be useful in the colourless reproduction of paintings (drawings, copper-plate engravings, &c.). Further, he constructs a photometer, in which, instead of the brightness-table, he employs a variable illumination of the object to be distinguished from it.

The specific gravity of liquid steel has been determined by Herr Alexjeff, by a method proposed by Herr Petruschewsky (*J. d. Russ. Chem. Phys. Ber.*, 12). A porcelain tube, open at both ends, was connected at one end with a forcing pump and a manometer, while the other end was immersed in liquid steel to a given depth (the tube vertical). On pumping, bubbles appeared at the latter end; and the indication of the manometer at that moment, compared with the depth of immersion, served for determination of the relative density of the steel and the liquid (naphtha) used in the manometer. The specific gravity of liquid steel was thus found to be 8·05, and so, greater than that of solid steel.

According to Herr Antolik (*Wied. Ann.*, 3) very regular and pure Lichtenberg figures are obtained on spherical glass vessels filled with warm water at about 60° C. The surface can be made at will electrically positive or negative (which is not the case with ebonite or resin). Wires are inserted which are furnished with balls at their upper end. If positive electricity be introduced, electricity of that kind becomes free at the surface, and on dusting with Villarsy's mixture, a quite homogeneous sulphur layer is produced. Very regular discs appear on drawing sparks with the knuckles. A number of interesting effects are described by the author.

Prof. H. M. Paul has communicated to the Seismological Society of Japan some notes on the effect of railway trains in transmitting vibrations through the ground. A box holding about twenty pounds of mercury thickened by amalgamation with tin, was placed upon a heavy plank screwed to the top of a post sunk 4½ feet into the ground. Images reflected in the surface of the mercury were observed by a telescope, as in meridian observations. An express train passing at a distance of one-third of a mile, set the surface of the mercury in confused vibration for two or three minutes. Other observations were made at stations at somewhat greater distances. The experimenter also found that a one-horse vehicle passing along a gravelled road 400 or 500 feet distant, caused a temporary agitation of the mercury whenever the wheels struck a small stone.

An extremely valuable series of notes on physiological optics, from the pen of W. Le Conte Stevens, has lately appeared in the *American Journal of Science*: most of these relate to stereoscopic vision and the theory of the stereoscope. They are both too valuable and too full of matter to render full justice possible in a brief note.

A new form of refractometer, producing interference-bands and rings between two pencils of light which have traversed paths at right angles to each other, is described by Mr. A. A. Michelson in the *American Journal of Science*. In the path of a ray from a lamp, a piece of plane-parallel glass is interposed at 45°. The two pencils respectively reflected and refracted are then returned along their own paths by mirrors normal to each; and these returning rays unite at the point whence they parted, giving a resultant ray at right angles to the former path. The theory of this refractometer is deduced by Mr. Michelson, who devised this apparatus for use in his experiments to test the hypothesis of a relative velocity between the earth and the luminiferous æther.

M. Violle finds the temperature of fusion of zinc free from lead, cadmium, arsenic, and other impurities to be 929·6° (C.); the value previously found by Edm. Becquerel was 932°; that given by Sainte-Claire Deville and Troost being 1040°.

The rapidly-reversed currents generated in an ordinary Bell telephone do not sensibly affect the needle of a galvanometer even when the loudest tones are being sung into the instrument. Nevertheless M Chardonnet has made the curious and interesting observation that during the short period while the note is increasing or diminishing in intensity, a deviation of the needle is observed. The explanation advanced is that during the rise or fall in intensity the alternate currents are no longer of equal strength, the odd semi-oscillations being either greater or less in amplitude than the even semi-oscillations during the period of rise or fall.

Some interesting new pieces of acoustical apparatus have been recently described by Herr Hartmann (*Wied. Beibl.* No. 3). The *motorophone* shows the change of rotatory motion into sounding motion, and the dependence of the qualities of the tone on the nature of the motion. A rapidly-rotated shaft has an adjustable eccentric with jointed rod, which at each rotation pulls a large drum-skin to and fro. A bell-mouth strengthens and concentrates the tones. The velocity of rotation determines the pitch; the eccentricity the strength of the tones. The *phonomotor* acts on the opposite principle, rotatory motion being got from vibration. In the *electromagnetophone* a piece of sheet-iron under an electro magnet has a point dipping in mercury; a current passing through the coils and the point becomes readily intermittent, and the membrane sounds. The *electromagnetic membrane-siren* is similar, but a solid sliding contact takes the place of the mercury, and a driving-wheel gives rapid interruption. Again, a tuning-fork is supported so as to be capable of rotation before a resonance-case. According to position it gives a strong resonance or a weak interference tone, the latter slightly higher. On rotating, the former becomes lower, the latter higher, and the dissonance ever greater. A *resonance-interference-pipe* is formed by connecting a caoutchouc tube with the nodes of an open pipe. If the tube be shortened by pressure at different parts, the tone of the pipe is raised or lowered through resonance-interference, is extinguished, or lets only the first overtone be heard. These instruments are made by G. F. Weigle, in Stuttgart.

CONTINUING his researches on "adsorption," or condensation of gases on surfaces of solids, Herr Kayser (*Wied. Ann.* No. 4) has studied the influence of the adsorbing material. The pressure was determined, which occurred in the glass vessel when given volumes of gas had been in contact with the solid material. The gases were carbonic acid, sulphurous acid, and ammonia, and these were adsorbed in the empty glass vessel, by coarse glass powder, and by turnings of brass and wrought iron. The metal-turnings were quite clean and unoxidised, and before each experiment they were heated *in vacuo* to about 300°, to remove gas. It was found that pressure was greatest, and so adsorption least, in the empty vessel. The order of increasing adsorption was, in general: empty vessel, iron, brass, and glass powder. By the empty vessel, SO_2 was least condensed, CO_2 and NH_3 about equally. Also, on the metallic surfaces, SO_2 always gave greater pressure than NH_3; between CO_2 and SO_2 there was hardly any difference. By the glass surfaces, on the other hand, CO_2 was comparatively little condensed, NH_3 considerably, and SO_2 to a large extent.

THE behaviour of mercury when polarised in contact with dilute sulphuric acid (as in Lippmann's well-known experiments), and with other acids and salt solutions, has been studied by Herr König at the instance of Prof. Helmholtz (*Wied. Ann.*, No. 5). The surface-tension, it is shown, reaches a maximum at a mean state of polarisation different for different liquids; the values diminishing on either side, as one removes from this, and both with positive and negative charges. Prof. Helmholtz offers some comments by way of theory on the phenomena.

FROM experiments at Würzburg (*Wied. Ann.*, No. 5), Mr. William Hallock infers the correctness of the view that the changes of electromotive force of the Smee element are due to action of polarisation. The electromotive force of polarisation is by no means independent (he affirms) of the nature of the electrodes, and it considerably exceeds that necessary for visible decomposition. The polarisation cannot be calculated from the heat phenomena.

To find whether the two coefficients used in equations of motion of incompressible liquids—one of viscosity, the other of variable adherence of the liquid to the walls—are independent of velocity, M. Elie (*Journ. de Phys.*, May) rotates a solid sphere within another filled with liquid, and hung bifilarly. The smaller sphere (0·04 m. diameter) is supported by a metallic wire passing through an aperture in the larger (0·12 m.) between the suspending wires to the vertical axis of an electric rotatory apparatus. During rotation (2 to 10 turns in a second) the hollow sphere is displaced to an amount indicated by a reflected light spot, and stops when the moment of the bifilar suspension balances that due to friction. In all the experiments with water, the reactions due to friction were found to increase more rapidly than the velocity; the ratio increased a third when the velocity was doubled; hence it appears that the viscosity or adherence, or both together, increase with the velocity.

THE name of *rheolyser* has been given by Prof. Wartmann to an apparatus (described in the *Archives des Sciences* for May) whereby the intensity of a derived electric current may be rapidly varied from zero to a maximum, and which indicates exactly the relation of those variations. A graduated metallic ring round a tripod-supported column encloses a thick disc of glass or ebonite, resting on the six radii of the ring. In the upper surface of the disc is a circular trough of mercury receiving two copper electrodes at the bottom, at a semicircle of interval. A cross-bar on the top of the column, on which it turns as axis, acts as a movable Wheatstone-bridge; it has two terminal verniers, and two screws dipping in the mercury; these latter are insulated, but communicate, through central binding screws, with a mirror galvanometer. The intensity of the derived current varies according as the bridge is displaced.

GEOGRAPHICAL NOTES

THE last work by Dr. E. Regel, on the Flora of Central Asia, which has recently appeared in the "Acta Horti Petropolitani" (vol. vii.), gives to Prof. Rehring, of Berlin, the opportunity of discussing the relations between the present flora and fauna of the North-eastern Asiatic Steppes, and the Post-glacial flora and fauna of Middle Europe. Prof. Regel, on the ground of his researches in Asia, arrived at the conclusion that out of the species which inhabited Central Asia during post-glacial times, very few have migrated towards north-western Asia and to Europe, and that the species now inhabiting this part of Asia have probably immigrated from Europe. The same was the conclusion arrived at several years ago by Dr. Rehring, when he and Dr. Liebe discovered in the Diluvium of Germany (at Westregeln and at Gera), a steppe-fauna much akin to the West Siberian (*Dipus jaculus*, *Arctomys bobac*, *Spermophilus altaicus*, *Lagomys pusillus*, *Equus caballus*, &c.), which facts led him to the inference that in post-glacial times middle Germany enjoyed a steppe vegetation and climate. The same steppe fauna has since been discovered at many other places in Germany, so that it may be said that the German diluvium encloses an unmistakable steppe fauna. Dr. Rehring discovers in Dr. Regel's work new proofs in favour of his theory of migration of the diluvial fauna from Europe to Asia, in opposition to the theory of the late Dr. Brandt, who considered North-western Asia as the true fatherland of the European diluvial fauna. We may observe that Dr. Rehring's theory would imply the migration of the German steppe fauna, not only to North-western Siberia, but also to Eastern Siberia, during the post-glacial period, which would involve several important difficulties. We believe that a true theory of the migrations of post-glacial faunas can be established only by taking into account the history of the glacial period in Asia, which history has never investigated.

DISCUSSING the character of the Glacial period on the Caucasus, M. Moushketoff points out (*Izvestia*, vol. xviii. fasc. 2), those features which are common to the former glaciers of the Caucasus, and those of the Zerafshan in Central Asia. He observes the present comparatively small extent of glaciers and snow-fields in both countries. The area now covered with perpetual snow on the Caucasus is very small (250 square kilometres) compared with the extent of the same regions in the Alps (more than 3000 square kilometres). The same relations—M. Moushketoff says—must have existed to some extent between both countries during the Glacial period, because of the greater dryness of climate on the Caucasus, and still more in Central Asia, in comparison with Western Europe. He concludes, in accordance with M. Abich and many others, that the ancient glaciers of the Caucasus had a far greater extension than the present ones (for instance, those of the Elbrouz reached, at least, down to 5200 feet, and the Baskan glacier united into one single mass all the present small glaciers which do not now descend lower than 6600 to 8600 feet). Nevertheless the glaciation was not so general as in Western Europe. This conclusion only must be provisional, the traces of the Glacial period having not yet been the subject of a thorough exploration, either on Caucasus or in Turkestan, whilst the obliteration of these traces has been far more complete in both these countries than in Europe. Taken in its widest sense, the supposition that the glaciation has been less intense in Middle Asia than in Europe seems very probable, and has been arrived at also by other explorers of Turkestan and Siberia.

BESIDES the Annual Address of the President, Lord Aberdare, reviewing the geographical progress of the year, the June number of the *Proceedings* of the Royal Geographical Society contains Mr. O'Donovan's paper on Merv; M. de Gorloff's account of his journey in the Atlas and the Northern part of the Algerian Sahara; the Rev. Thos. Wakefield's fourth journey to the Southern Galla country; and Capt. Paiva de Andrada's Zambesi Expedition, 1881. We learn that the Search Expedition for Mr. Leigh Smith is now organised, and will be commanded by Sir Allen Young. The expedition will leave this month.

FROM a letter of Consul H. E. O'Neill in the June number of the Geographical Society's *Proceedings*, it would seem that the "snow-clad Irati" spoken of by Messrs. Maples and Goldfinch as reported to exist in the country south-east of Lake Nyassa, is probably a delusion. Mr. O'Neill was close to the mountain, which he estimates at not more than between 5000 to 6000 feet above the sea.

MISS ELLEN M. TAYLOR has compiled a very useful guide-book to Madeira, under the title of "Madeira: its Scenery, and How to See It" (Stanford). She gives the very kind of information intending visitors are likely to want, and the possession of which will save them much trouble. While Miss Taylor draws largely on existing authorities, she also gives the results of her own experience. Her list of trees, flowers, ferns, and seaweeds will be useful to the amateur naturalist.

THE first paper in the June number of *Petermann's Mittheilungen* is on M. Charnay's expedition to the ruins in Central America, by Herr Fred. Kofler. Dr. Hermann J. Klein has an article of much interest on "Some Volcanic Formations in the Moon," in which he suggests that the lunar surface ought to be carefully examined by geologists, in order to discover the exact condition of things as compared with terrestrial geology. There is a short account of Oschanin's exploration of Karategin in 1878, and a very useful paper by Herr B. Hassenstein, on the geographical and cartographical literature of the Indo-Chinese border-lands, with a map of the Tibetan and Indo-Chinese border-region.

THE last number of the *Izvestia* of the Russian Geographical Society (vol. xviii. fasc 2), contains a good many valuable papers. We notice among them the preliminary report on the geological exploration of the former beds of the Amu-daria, by A. E. Hedroitz; a paper by M. Mousketoff on his geological exploration of the Caucasus; a description of an excursion to Seraks, by P. M. Lessar, with a map of the route between Askabad and Seraks; a notice by A. Regel of his journey to the Karategin and Darvaz, dated Kala-i-Khumb, with a map; on the sands of Ferghana, by M. W. Malakhoff, and a variety of small notices. We are glad to learn that the *Izvestia* will have a special department, "Polar News," devoted to all that concerns the exploration of Polar regions; it will be under the direction of Baron Wrangel.

WE learn from the *Izvestia* of the Russian Geographical Society that Dr. A. E. Regel has returned from his journey to Karategin and Darvaz to Samarkand, and is preparing for a new journey to the Pamir.

PROF. NORDENSKJÖLD has telegraphed to the Mayors of Tromsö, Hammerfest, and Vardö, on behalf of Herr Oscar Dickson, of Gothenburg, asking them to acquaint skippers leaving for the Arctic Sea, with the rewards offered by Herr Dickson for the Discovery of the *Eira*, viz. 225*l*. to be paid to the one who may first relieve Mr. Leigh Smith or any of his companions; 140*l*. to the one who may first discover and give information in writing of the crew of the *Eira*, of a later date than November 1 last, 56*l*. for the first information, by telegraph, addressed to Herr Oscar Dickson, that any one of the crew of the *Eira* has been found, or a letter from either of a later date than that of November 1 last.

THE German Antarctic expedition, consisting of Dr. Schrader and six companions, have sailed by the Hamburg mail steamer for Monte Video, thence by Imperial corvette to the island of South Georgia, to establish a scientific station for meteorological observations. They will remain twelve months.

AT the last meeting (May 30) of the Russian Geographical Society, the Secretary said that a telegram received from Irkutsk announces the possibility of establishing seven new meteorological stations in the far north, namely, at Verkhoyansk, Orlensk, Witimsk, Olekminsk, Kirensk, Nokhtuisk, and Preobrajensk, besides the station already established at the mouth of the Lena. The necessary instruments will be forwarded immediately by the Central Meteorological Observatory. At the same meeting, M. Rykatcheff made a communication on tides in the atmosphere. He proved the correctness of the theory of Laplace with regard to atmospherical tides by the discussion of a very great number of anemometrical observations.

PROF. LENSTRÖM, Secretary of the Meteorological Commission of the Society of Science in Finland, anxious that Finland may participate in the Circumpolar observations, has offered to erect a station at Sodankylä (67° 20′ N., 26° 40′ E.), which proposition has been accepted by the President of the International Congress, Dr. H. Wild, of St. Petersburg.

THE ROYAL OBSERVATORY

THE annual visitation of the Royal Observatory took place on Saturday, when the Astronomer-Royal, Mr. W. H. M. Christie, presented his report.

"The Report," Mr. Christie states, "here presented, refers to the period of twelve months, ending May 20, 1882, a fixed date being taken, conveniently near to the visitation day. Sir G. B. Airy resigned his office on August 15, 1880, and a portion of the observations here referred to were made under his superintendence. There seems to be no occasion to separate these from the remainder, as the course of observation which Sir G. B. Airy has carried out for so many years has been continued without essential alteration in its main features."

Of the Transit of Venus instruments the Report states, two transits, three altazimuths, five 6-inch equatoreals, two photoheliograph mountings, nine clocks, and one Transit of Venus model have been sent to Mr. Stone at Oxford for use in the forthcoming Transit of Venus, and three transits, an altazimuth, a photoheliograph, and two clocks are at the Cape of Good Hope, where they will be available for the Transit of Venus.

A series of pendulum observations was made in the record room last autumn by Major Herschel, R.E.

After giving details as to the usual astronomical observations, the altazimuth, and other matters, Mr. Christie goes on to speak of the spectroscopic and photographic observations:—

"During the twelve months ending May 20, 1882, the sun's chromosphere has been examined with the half-prism spectroscope on 36 days, and on every occasion prominences were seen. On one day a detailed examination of the whole spectrum of the chromosphere was made at 24 points on the sun's limb. Several prominences have shown great changes in the course of two or three minutes, and large displacements or contortions of the bright lines, indicating very rapid motions of approach or recession have been noted. In particular, a prominence examined on May 13, 1882, was observed to rise through a space of about 30′ in less than two minutes, being at the rate of about 110 miles a second, whilst the C line showed a displacement towards the red gradually increasing from $1\frac{1}{4}$ to 11·4 tenth metres, corresponding to a motion of recession increasing in two minutes from 36 to 330 miles a second. Thirteen sun-spots have been examined on 20 days with reference to the broadening of the lines in their spectra. The strong black lines or bands in the part of the spectrum between *b* and F, first noticed in the spectrum of a spot on November 27, 1880, have been generally observed to be present in the spectra of spots during the last twelve months, besides several fine lines in the same region of the spectrum to which there is nothing corresponding in the solar spectrum. For the determination of motions of stars in the line of sight, 177 measures have been made of the displacement of the F line in the spectra of 41 stars, 68 of the b_1 line in 19 stars, and 9 of the b_4 line in 5 stars. Of the 61 stars observed, 15 had not previously been examined, and the total number of stars of which the motions have been spectroscopically determined, is now 106. In the case of three of the stars observed in the last year, a dispersive power equivalent to that given by sixteen prisms of 60° has been used. A comparison of the successive determinations of the motion of Sirius indicates a progressive diminution from about 22 miles a second in 1877 and 1878, to about 7 miles a second or less this year, and as other stars do not show anything similar, it appears likely that the change is due to the orbital motion of Sirius. Further observations will, however, be required to settle the point. The spectrum of Comet *b* 1881, was examined on six nights, that of Comet *e* 1881, on three nights, and that of Comet *a* 1882, on three nights. The spectra of the first two objects showed the usual cometary bands corresponding to those of the first spectrum of carbon, and a continuous spectrum from the nucleus and brighter portions of the head. Comet *a* 1882, has hitherto shown only a continuous spectrum with two irregular ill-defined maxima of light. The observations of this comet are being continued."

In the year ending May 20, 1882, photographs of the sun have been taken on 200 days, and of these 352 have been selected for preservation. Since the end of last August photographs have been taken on Sundays as well as on week days. There were only 2 days out of 200 on which the sun's disk was observed to be free from spots. There has been a large increase in the number and size of spots and faculæ, the mean of the daily areas for each in 1881 being nearly double of the corresponding quantities for 1880, and the increase is still continuing, though with well-marked fluctuations. A very remarkable outbreak of spots occurred in April last.

With regard to magnetical observations the report states that no important change has been made in the three magnetometers with which the changes in the magnetic declination, horizontal force, and vertical force are continuously recorded by photography.

"The large temperature correction for the vertical force magnet has made it impracticable to discuss satisfactorily the diurnal inequality of vertical force and its dependence on solar activity, notwithstanding the great care taken to keep the magnetic basement at as nearly uniform a temperature as possible. After giving details as to rearrangements of the earth-current apparatus, the report states that "on four days during the year, viz., September 12 and 13 and April 16 and 19, magnetic storms have occurred. Those of April were of more marked character than any that have taken place since the great storms of the year 1872, and it is a significant fact that exceptionally large spots made their appearance on the sun shortly before, viz., on April 11 and 17. Smaller magnetic movements are now also much more frequent, the traces exhibiting a marked contrast to their general appearance some two or three years ago. In regard to the long period variation of about 11 years, we are able now to say definitely that the minimum as regards diurnal range of declination occurred at the commencement of 1879, whilst as regards diurnal range of horizontal force, it occurred unmistakeably earlier, about August, 1878. Since the epochs mentioned, each element has, with small fluctuations, continued regularly to increase again in magnitude, the daily range of declination having increased from 6′·59 at the beginning of 1879 to 9′·15 in 1881, and that of horizontal force from ·00110 (in parts of the whole H.F.) in 1878 to ·00181 in 1881. We have frequent applications from mining surveyors for the values of the magnetic elements, and recently the wish has been expressed that information as to the diurnal inequality and particulars of magnetic storms observed here should be communicated from time to time to the *Colliery Guardian* newspaper, in order that mining surveys may be carried out with due allowance for the diurnal and other motions of the magnetic needle."

Under the heading of Meteorology, the Report states that "the mean temperature of the year 1881 was 48°·7, being 0°·6 lower than the average of the preceding 40 years. The highest air temperature was 97°·1 on July 15, and the lowest 12°·7 on January 17. The mean temperature was below the average, 6°·7 in January and 4°·8 in October, and above the average, 5°·9 in November. In other months the temperature in general differed little from the average. On four days in July the temperature rose above 90°. The mean daily motion of the air in 1881 was 291 miles, being 12 miles greater than the average. In January and September the mean daily motion was 70 miles and 72 miles below the average respectively. In April, August, and November it was 70 miles, 60 miles, and 71 miles above the average respectively. The greatest daily motion was 999 miles on October 14, the day of the great storm, and the least, 59 miles on May 25. A velocity of 61 miles an hour was recorded on October 14, and one of 58 miles an hour on April 29, these being both greater than any recorded in previous years. The greatest pressure was 53 lbs. on the square foot on October 14; pressures of 46, 47, and 48 lbs. were also registered during the same gale. On April 29 a pressure of 49½ lbs. was recorded at a time when the hourly velocity was 50 miles; the pressures corresponding to the maximum velocity of 58 miles an hour were not registered, the cord of the pressure pencil having slipped off the pulley."

"The volume of Greenwich Observations for 1879 was printed and distributed last autumn, and the volume for 1880 was passed for press in the middle of April. The copies are now in the binder's hands. As regards the volume for 1881, the transits are printed to May 19, meridian zenith distances to April 27, azimuths with the altazimuth to March 31, and zenith distances to June 2."

"The number of chronometers now being tested at the Observatory is 214, 168 of which (120 box-chronometers, 23 pocket-chronometers, and 25 deck-watches) belong to the Government, and are being rated after repair previous to being issued to the navy. The remaining 46 are placed here for the annual competitive trial, and of these 18 are fitted with Airy's supplementary compensation. In addition to the above, 6 chronometers have been placed on trial for the Mauritius Observatory, and 5 chronometers have been tested for the Japanese Government.

"There has been only one case of accidental failure in the automatic drop of the Greenwich time-ball. On four days the ball was not raised, on account of the violence of the wind. The Deal ball has been dropped automatically at 1h. on every day throughout the year, with the exception of 15 days, on which there was either failure in the telegraphic connection, or interruption from telegraph signals continuing up to 1h., and of one day when the current was too weak to release the trigger without the attendant's assistance. On 3 days, high winds made it imprudent to raise the ball. The Westminster clock has continued to perform well, its errors having been under 1s. on 40 per cent. of the days of observation, between 1s. and 2s. on 44 per cent., between 2s. and 3s. on 14 per cent., and between 3s. and 4s. on 2 per cent. Time-signals, originating in the Observatory, are distributed at 10 a.m. and 1 p.m. to all parts of the country by the Post Office telegraphs."

Mr. Christie concludes his Report by referring to some new arrangements for calculations and observations, which will greatly economise the time and labour of the staff. The staff, indeed, seems inadequate to the constantly increasing work. With reference to spectroscopic observation, for example, Mr. Christie says:—"With only one assistant available for observations, we can barely do half of the work which we have undertaken in deference to a widely-expressed wish, and we are continually forced to make a choice between observations with conflicting claims on our attention. As regards solar photography, the value of our results would be very greatly increased if the gaps in the Greenwich series were filled up by the help of the photographs taken in India and elsewhere under the auspices of the Solar Physics Committee, so that the areas and positions of sun-spots and faculæ should be given for every day. I am in communication with the Committee on this matter, and am in hopes that the saving of labour recently effected in our photographic reductions will enable us to undertake the work with our existing staff."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The honorary degree of D.C.L. will be conferred at the approaching Encænia upon the following among other distinguished persons:—Baron Nordenskjöld, Dr. Allen Thomson, and M. Pasteur.

CAMBRIDGE.—The election of a Professor of Animal Morphology took place on May 31, when Mr. Francis Maitland Balfour, M.A., F.R.S., Fellow of Trinity College, was by an unanimous vote of the members of the electoral roll selected to fill the newly-established chair. The professorship was established by a grace of the Senate passed on May 11 by virtue of the provisions of the University Statute for the establishment of additional professors. The stipend attached to the chair is 300*l*. per annum, and it is provided the professorship shall terminate with the tenure of office of the professor first elected unless the University shall decide that the professorship shall be continued. The Council of the Senate in their report recommending the foundation of the professorship laid stress on the fact that the teaching of biology in Cambridge had lately been most successful and had rapidly developed. The classes are now so large that the accommodation provided a few years ago had already become insufficient. It was well known that one branch of this teaching—viz. that of animal morphology, had been created in Cambridge by the efforts of Mr. F. M. Balfour, and that it had grown to its present importance through his ability as a teacher and his scientific reputation. The service to the interests of Natural Science thus rendered by Mr. Balfour having been so far generously given without any adequate academical recognition, the benefit of its continuance was entirely unsecured to the University, and the progress of the department under Mr. Balfour's direction remained liable to sudden check. Upon this representation the Senate unanimously concurred in the report of the Council and established the professorship.

EDINBURGH.—Dr. James Geikie, F.R.S., has been appointed to the Murchison Chair of Geology and Mineralogy in succession to Prof. Archibald Geikie, Director of the Geological Survey. Dr. Geikie will not enter upon the duties of his class till November next.

DR. P. PHILLIPS BEDSON, F.C.S., Demonstrator and assistant Lecturer on Chemistry in the Victoria University, Owens College, has been elected to the Professorship of Chemistry in the Durham University College of Physical Science, Newcastle-on-Tyne.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 25.—"On the Cause of the Light Border frequently noticed in Photographs just outside the Outline of a Dark Body seen against the Sky; with some Introductory Remarks on Phosphorescence." By Prof. G. G. Stokes, Sec. R.S.

An observation I made the other day with solar phosphori, though not involving anything new in principle, suggested to me an explanation of the above phenomenon which seems to me very likely to be the true one. On inquiring from Capt. Abney whether it had already been explained, he wrote: "The usual explanation of the phenomenon you describe is that the silver solution on the part of the plate on which the dark objects fall has nowhere to deposit, and hence the metallic silver is deposited to the nearest part strongly acted upon by light." As this explanation seems to me to involve some difficulties, I venture to offer another.

1. I will first mention the suggestive experiment, which is not wholly uninteresting on its own account, as affording a pretty illustration of what is already known, and furnishing an easy and rapid mode of determining in a rough way the character of the absorption of media for rays of low refrangibility.

The sun's light is reflected horizontally into a darkened room, and passed through a lens,[1] of considerable aperture for its focal length. A phosphorus is taken, suppose sulphide of calcium giving out a deep blue light,[2] and a position chosen for it which may be varied at pleasure, but which I will suppose to be nearer to the lens than its principal focus, at a place where a section of the pencil passing through the lens by a plane perpendicular to its axis shows the caustic surface well developed. A screen is then placed to intercept the pencil passing through the lens, and the phosphorus is exposed to sunlight or diffuse daylight, so as to be uniformly luminous, and is then placed in position; the screen is then removed for a very short time and then replaced, and the effect on the phosphorus is observed.

Under the circumstances described there is seen a circular disk of blue light, much brighter than the general ground, where the excitement of the phosphorus has been refreshed. This is separated by a dark halo from the general ground, which shines by virtue of the original excitement, not having been touched by the rays which came through the lens.

2. The halo is due to the action of the less refrangible rays, which, as is well known, discharge the phosphorescence. Their first effect, as is also known, is, however, to cause the phosphorus to give out light; and if the exposure were very brief, or else the intensity of the discharging rays were sufficiently reduced, the part where they acted was seen to glow with a greenish light, which faded much more rapidly than the deep blue, so that after a short time it became relatively dark.

3. This change of colour of the phosphorescent light can hardly fail to have been noticed, but I have not seen mention of it. In this respect the effect of the admission of the discharging rays is quite different from that of warming the phosphorus, which, as is known, causes the phosphorus to be brighter for a time, and then to cease phosphorescing till it is excited afresh. The difference is one which it seems important to bear in mind in relation to theory. Warming the phosphorus seems to set the molecules more free to execute vibrations of the same character as those produced by the action of the rays of high refrangibility. But the action of the discharging rays changes the character of the molecular vibrations, converting them into others having on the whole a lower refrangibility, and being much less lasting.

4. Accordingly when the phosphorus is acted on simultaneously by light containing rays of various refrangibilities, the tint of the resulting phosphorescence, and its more or less lasting character, depend materially upon the proportion between the exciting and discharging rays emanating from the source of light. Thus daylight gives a bluer and more lasting phosphorescence than gaslight or lamplight. I took a tablet which had been exposed to the evening light, and had got rather faint, and, covering half of it with a book, I exposed the other half to gaslight. On carrying it into the dark, the freshly exposed half was seen to be much the brighter, the light being, however, whitish, but after some considerable time the unexposed half was the brighter of the two.

Again, on exposing a tablet, in one part covered with a glass vessel containing a solution of ammonio-sulphate of copper, to the radiation from a gas flame, the covered part was seen to be decidedly bluer than the rest, the phosphorescence of which was whitish. The former part, usually brighter at first than the rest, was sure to be so after a very little time. The reason of this is plain after what precedes.

A solution of chromate of potash is particularly well suited for a ray filter when the object is to discharge the phosphorescence of sulphide of calcium. When it stops the exciting rays, it is transparent for nearly the whole of the discharging rays. The phosphorescence is accordingly a good deal more quickly discharged under such a solution than under red glass, which, along with the exciting rays, absorbs also a much larger proportion than the chromate of the discharging rays.

5. I will mention only one instance of the application of this arrangement to the study of absorption. On placing before excited sulphide of calcium a plate of ebonite given me by Mr. Preece as a specimen of the transparent kind for certain rays of low refrangibility, and then removing the intercepting screen from the lens, the transmission of a radiation through the ebonite was immediately shown by the production of the greenish light above-mentioned. Of course, after a sufficient time the part acted on became dark.

6. I will mention two more observations, as leading on to the explanation of the photographic phenomenon which I have to suggest.

In a dark room, an image of the flame of a paraffin lamp was thrown by a lens on to a phosphorescent tablet. On intercepting the incident rays after no great exposure of the tablet, the place of the image was naturally seen to be luminous, with a bluish light. On forming in a similar manner an image of an aperture in the window shutter, illuminated by the light of an overcast sky reflected horizontally by a looking-glass outside, this image of course was luminous; it was brighter than the other. On now allowing both lights to act simultaneously on the tablet, the image of the flame being arranged to fall in the middle of the larger image of the aperture, and after a suitable exposure cutting off both lights simultaneously, the place of the image of the aperture on which the image of the lamp had fallen was seen to be *less* luminous than the remainder, which had been excited by daylight alone. The reason is plain. The proportion of rays of lower to rays of higher refrangibility is much greater in lamplight than in the light of the sky; so that the addition of the lamplight did more harm by the action of the discharging rays which it contained on the phosphorescence produced by the daylight, than it could do good by its own contribution to the phosphorescence.

7. The other observation was as follows:—The same tablet was laid horizontally on a lawn on a bright day towards evening, when the sun was moderately low, and a pole was stuck in the grass in front of it, so as to cast a shadow on the tablet. After a brief exposure, the tablet was covered with a dark cloth, and carried into a dark room for examination.

It was found that the place of the *shadow* was *brighter* than the general ground, and also a deeper blue. For a short distance on both sides of the shadow the phosphorescenco was a little feebler than at a greater distance.

This shows that, though the direct rays of the sun by themselves alone would have strongly excited the phosphorus, yet

---

[1] The lens actually used was one of crown glass which I happened to have; a lens of flint glass would have been better, as giving more separation of the caustic surfaces for the different colours.

[2] The experiments were actually made, partly with a tablet painted with Balmain's luminous paint, partly with sulphide of calcium and other phosphori in powder.

acting along with the diffused light from all parts of the sky, they did more harm than good. They behaved, in fact, like the rays from the lamp in the experiment of Section 6. The slightly inferior luminosity of the parts to some little distance on both sides of that on which the shadow fell, shows that the loss of the diffuse light corresponding to the portion of the sky cut off by the pole was quite sensible when that portion lay very near the sun.

All this falls in very well with what we know of the nature of the direct sunlight and the light from the sky. In passing through the atmosphere, the direct rays of the sun get obstructed by very minute particles of dust, globules of water forming a haze too tenuous to be noticed, &c. The veil is virtually coarser for blue than for red light, so that in the unimpeded light the proportion of the rays of low to those of high refrangibility goes on continually increasing, the effect by the time the rays reach the earth increasing as the sun gets lower, and has accordingly a greater stretch of air to get through. Of the light falling upon the obstructing particles, a portion might be absorbed in the case of particles of very opaque substances, but usually there would be little loss this way, and the greater part would be diffused by reflection and diffraction. This diffused light, in which there is a predominance of the rays of higher refrangibility, would naturally be strongest in directions not very far from that of the direct light; and the loss accordingly of a portion of it where it is strongest, in consequence of interception by the pole in front of the tablet, accounts for the fact that the borders of the place of the shadow were seen to be a little less luminous that the parts at a distance.

8. The observations on phosphorescence just described have now prepared the way for the explanation I have to suggest of the photographic phenomenon.

It is known, that with certain preparations, if a plate be exposed for a very short time to diffuse daylight, and be then exposed to a pure spectrum in a dark room, on subsequently developing the image it is found, that while the more refrangible rays have acted positively, that is, in the manner of light in general, a certain portion of the less refrangible have acted in an opposite way, having undone the action of the diffuse daylight to which the plate was exposed in the first instance.

It appears then that in photography, as in phosphorescence, there may in certain cases be an antagonistic action between the more and less refrangible rays, so that it stands to reason that the withdrawal of the latter might promote the effect of the former.

Now the objective of a photographic camera is ordinarily chemically corrected; that is to say, the minimnm focal length is made to lie, not in the brightest part of the spectrum, as in a telescope, but in the part which has strongest chemical action. What this is, depends more or less on the particular substance acted on; but taking the preparations most usually employed, it may be said to lie about the indigo or violet. Such an objective would be much under-corrected for the red, which accordingly would be much out of focus, and the ultra-red still more so.

When such a camera is directed to a uniform bright object, such as a portion of overcast sky, the proportion of the rays of different refrangibilities to one another is just the same as if all the colours were in focus together; but it is otherwise near the edge of a dark object on a light ground. As regards the rays in focus, there is a sharp transition from light to dark; but as regards rays out of focus, the transition from light to dark, though rapid, is continuous. It is, of course, more nearly abrupt the more nearly the rays are in focus. Just at the outline of the object there would be half illumination as regards the rays out of focus. On receding from the outline on the bright side, the illumination would go on increasing, until on getting to a distance equal to the radius of the circle of diffusion (from being out of focus) of the particular colour under consideration, the full intensity would be reached. Suppose, now, that on the sensitive plate the rays of low refrangibility tend to oppose the action of those of high refrangibility, or say act negatively, then just outside the outline the active rays, being sharply in focus, are in full force, but the negative rays have not yet acquired their full intensity. At an equal distance from the outline on the dark side, the positive rays are absent, and the negative rays have nothing to oppose, and therefore simply do nothing.

9. I am well aware that this explanation has need of being confronted with experiment. But not being myself used to photographic manipulation, I was unwilling to spend time in attempting to do what could so much better be done by others. I will, therefore, merely indicate briefly what the theory would lead us to expect.

We might expect, therefore, that the formation of the fringe of extra brightness would depend :—

(1) Very materially upon the chemical preparation employed. Those which most strongly exhibit the negative effect on exposure to a spectrum after a brief exposure to diffuse light might be expected to show it most strongly.

(2) Upon the character of the light. If the light of the bright ground be somewhat yellowish, indicating a deficiency in the more refrangible rays, the antagonistic effect would seem likely to be more strongly developed, and, therefore, the phenomenon might be expected to be more pronounced.

(3) To a certain extent on the correction of the objective of the camera. An objective which was strictly chemically corrected might be expected to show the effect better thaa one in which the chemical and optical foci were made to coincide, and much better than one which was corrected for the visual rays.

It is needless to say that on any theory the light must not be too bright, or the exposure too long; for we cannot have the exhibition (in the positive) of a brighter border to a ground which is white already.

P.S.—Before presenting the above paper to the Royal Society I submitted it to Capt. Abney, as one of the highest authorities in scientific photography, asking whether he knew of anything to disprove the suggested explanation. He replied that he thought the explanation a possible one, encouraged me to present the paper, and kindly expressed the intention of submitting the question to the test of experiment.

Linnean Society, May 24.—Auniversary Meeting.—Sir John Lubbock, Bart., F.R.S., president, in the chair.—Mr. H. T. Stainton, on behalf of the Audit Committee, read the statement of receipts and payments for the year, and the Treasurer, Mr. Frank Crisp, followed with a detailed explanation of the various items, showing that the Society was in a very sound financial condition; besides investments of about 4000*l.*, the balance at bankers' being 649*l.* 2*s.* 5*d.* Afterwards the secretary, Mr. B. D. Jackson, read his annual report. Since the last auniversary, fifteen Fellows of the Society, 2 Foreign Members, and 1 Associate, had died, and 7 Fellows had withdrawn; while 40 new Fellows had been elected. Between purchase, exchange, and donations, 383 vols. and 348 separate parts had been added to the Library.—The President then delivered his anniversary address, commenting generally on the events of the past year with especial reference to their bearing upon the Society; he also made allusions to the removal of the Botanical Department of the British Museum to South Kensington, and to the additions of Miss North's oil paintings, &c., to Kew Gardens; this was followed by reports on the various botanical and zoological publications published during the last twelvemonth. The obituary notices of deceased Fellows was read by the Secretary, the Society having to deplore the loss of Charles Darwin, Professor Rolleston, Sir C. Wyville Thomson, and their late treasurer, Mr. Frederick Currey, who had been in office above twenty years. The scrutineers having examined the ballot, then reported that Mr. H. W. Bates. T. S. Cobbold, Prof. P. M. Duncan, E. M. Holmes, and Sir J. D. Hooker had been elected into the Council, in the room of Prof. Allman, Rev. J. M. Crombie, W. S. Dallas, A. Grote, and Prof. Lankester, who retired; and for officers, Sir J. Lubbock as president, Frank Crisp as treasurer, and B. D. Jackson and G. J. Romanes.

MANCHESTER

Literary and Philosophical Society, March 13.—Alfred Brothers, F.R.A.S., in the chair.—Mr. Marcus M. Hartog, F.L.S., made a communication upon water-fleas.—On *Cypræa guttata* (Gmel.), by J. Cosmo Melvill, F.L.S.—Lepidoptera of the Shetland Islands, by Hastings C. Dent, C.E.—Notes on the Giant Dragon's-blood tree at Orotava, by Mr. John Plant, F.G.S.—Mr. R. D. Darbishire, B.A., F.G.S., exhibited a fine series of Ceylonese land and freshwater shells, procured through the instrumentality of Mr. M. M. Hartog, F.L.S.

April 17.—Annual Meeting.—Mr. Boyd remarked upon the discovery of the egg-cases of *Pediculis capitis* in the crevices in an African chief's head stool in the possession of a friend of his.—Mr. Plant stated that he had endeavoured to obtain larger specimens of the Dreissena noted at the last meeting, but without success.—Dr. Alcock concluded his notes on frog tadpoles by describing the three remaining periods into which their life-history may be divided.

Berlin

Physical Society, May 12.—Prof. Du Bois-Reymond in the chair.—Dr. Herz spoke on hardness. The methods hitherto used to determine the hardness of bodies have all been merely comparative estimates, *e.g.* in mineralogy it has been stated by what other substances the material in question is scratched, and what it can scratch, and so its position in the scale of hardness is shown to be between these others. Or it has been ascertained by some physicists to what depth in the substance a steel cone is pressed by a given force, and this depth gives a measure of the hardness. Herr Herz has sought a more absolute method; and he has confined himself, on account of the complexity of the question, to consideration of isotropic elastic substances. In these the hardness may be determined by the pressure which must be exerted on a round surface, to exceed, by the deformation produced, the limit of elasticity. In the case of plate-glass, *e.g.* it was found by experiment, that at a pressure of 136 kg. per square mm., the limit was passed, and a circular crack was produced; 136, accordingly, expresses the degree of hardness of the glass. Every isotropic body which has exceeded its limit of elasticity under greater or less pressure, is, respectively, harder or less hard. The advantage of this method lies in the fact that no second substance is needed, but only two balls or lenses of the substance examined.—Prof. Christiani then showed, as samples of a new method of preservation a series of organic bodies coated galvanoplastically; a mulberry leaf, a crab, a butterfly, a beetle, the brain of a rabbit, a rosebud, and other objects, were silver-, gold-, or copper-plated, and showed all details of their outer form, down to the finest shadings, very well preserved. As to the process (which is patented by the inventor), it was stated that the objects to be preserved, being put, living or dead, into a solution of silver nitrate in alcohol, then dried, and treated with sulphuretted and phosphuretted hydrogen, form good conductors, which, brought in the usual way into the galvanoplastic bath, can be coated with any desired thickness of a metallic deposit.

Gottingen

Royal Society of Sciences, January 7.—Contribution to the theory of surfaces, with special reference to minimal surfaces, by A. Enneper.

February 4.—Report on the Polyclinic for ear diseases, by K. Burkner.—Completion of Steiner's elementary geometrical proofs of the proposition that the circle has a greater surface-content than any other plane figure of equal circumference, by F. Edler.

March 4.—On functions which remain unchanged by linear substitutions, by L. Fuchs.—Measurement of the earth's magnetic horizontal intensity by means of bifilar suspension of a magnet, by F. Kohlrausch.—Contribution to the theory of surfaces, &c. (continued), by A. Enneper.—On cryolith, pachnolith, and thomsonolith, by C. Klein.—Communications on Giordano Bruno, by P. de Lagarde.—Report on Beneke prize.

Paris

Academy of Sciences, May 29.—M. Blanchard in the chair.—The following papers were read:—Separation of gallium, by M. Lecoq de Boisbaudran.—On the cycle of reasoning; its use for formulating and strengthening the fundamental hypotheses and propositions of all science; application to mechanics, by M. Ledieu. The cycle includes four operations: (1) observation and, if necessary, experimentation *a priori*; (2) induction; (3) deduction; (4) experimentation and, at least, observation *a posteriori*. A fundamental hypothesis or law is more or less rational when, on submitting it to the cycle, one can more or less close this cycle. The author illustrates this.—Report on a memoir of M. Bouquet de la Grye entitled, "Study on Waves of Long Period in the Phenomena of Tides." In this memoir the author extends the work of Laplace. It is also proved, *inter alia*, that the greatest elevation of the water at Brest occurs, not with west but with south winds. The density of the water is found to explain the unexpected fact revealed by Bourdaloue, that the mean level of the ocean at Brest is higher by 1·02 m. than that of the Mediterranean at Marseilles. From 1834 to 1878 the mean level of the ocean has sunk, at Brest, or the ground has risen (the fact subsists, after allowing for variation of temperature and saltness). The relative rise of ground has been about 1 mm. a year.—Measurement of the volume of blood contained in the system of a live mammal, by MM. Gréhant and Quinquaud. The method used depends on carbonic oxide giving an oxycarbonised hæmoglobin, a more fixed combination than oxygenated hæmoglobin (the carbonic oxide being substituted for the oxygen volume for volume). An animal is made to breathe gas containing a known amount of CO. The volume of CO remaining is noted, say, in a quarter of an hour, and this gives the amount fixed. On the other hand, the blood is analysed to find the CO fixed in a given volume. In this way it was found that the total weight of blood is between 1-12th and 1-13th of the body-weight. In the normal state there are no great variations.—Obervations to serve in the study of phylloxera, by M. Boiteau.—On a proposition relative to linear equations, by M. Darboux.—Demonstration of a theorem relative to the function $E(x)$, by M. Bouniakowski.—Two means of having π in the game of head or tail, by M. Barbier.—On a mode of transformation of figures in space, by M. Vanecek.—On a potential with four variables, which renders almost intuitive the integration of the equation of sound, and the demonstration of the formula of Poisson concerning the inverse potential with three variables, by M. Boussinesq.—On the actinic transparence of optical glasses, by M. de Chardonnet. A species of glass only allows passage (even with thin plates, and with long exposure) to wave-lengths exceeding a certain minimum, characteristic of the material. Another characteristic is the thickness beyond which elective absorption diminishes no further. With these limits, the shortening of the spectrum seems sensibly proportional to the thickness of the medium. The actinic absorption (measuring the shortening of the spectrum in the scale of wave-lengths) for a given optical system is comprised between the absorption of the least transparent glass and the sum of proportional shortenings due to all the glasses of the apparatus.—Action of sulphydrate of ammonia on sulphide of tin, by M. Ditte.—Influence of the tension of sulphuretted hydrogen in presence of a neutral solution of sulphate of nickel, by M. Baubigny.—On the transformations of cuproso-cupric sulphites, by M. Étard.—Determination of glycerine in fatty matters, by M. David. He saponifies 100 gr. of tallow with baryta.—On the ligneous formations produced in the pith of cuttings, by M. Prillieux.—On the true situation of the mouth of the Shiré, and on the canal of communication connecting this river with the Zambesi, by M. Guyot. Correcting the notion that the Shiré, after entering the lake of Lydia, resumes its course and joins the Zambesi near the foot of Chamouara, he represents that the lake is really connected with the Zambesi by a canal called Zio-Zio; running first W.S.W. to E.N.E., then nearly east, which conveys water *from* the Zambesi and is a larger feeder of the lake than the Shiré (the latter at its entrance into the lake is only about 670 feet wide and 3 to 4 feet deep, with little current).

CONTENTS

THURSDAY, JUNE 15, 1882

CHARLES DARWIN[1]

IV.

IN attempting to estimate the influence which Mr. Darwin's writings have exerted on the progress of botanical science, a little consideration will show that we must discriminate between the indirect effect which his views have had on botanical research generally, and the direct results of his own contributions. No doubt in a sense the former will seem in the retrospect to overshadow the latter. For in his later writings Mr. Darwin was content to devote himself to the consideration of problems—with an insight and patience essentially his own—which, in a limited field, brought his theoretical views to a detailed test, and so may ultimately seem to be somewhat merged in them. It is wonderful enough that so great a master in biological science should, at an advanced age, have been content to work with all the fervour and assiduity of youth at phenomena of vegetable life apparently minute and of the most special kind. But to him they were not minute, but instinct with a significance that the professed botanical world had for the most part missed seeing in them failing the point of view which Mr. Darwin himself supplied. It is not too much to say that each of his botanical investigations, taken on its own merits, would alone have made the reputation of any ordinary botanist.

Mr. Darwin's attitude towards botany, as indeed to biological studies generally, it should always be remembered was in his early life essentially that of a naturalist of the school of Linnæus and Humboldt—a point of view unfortunately now perhaps a little out of fashion. Nature in all its aspects spoke to his feelings with a voice that was living and direct. The writer of these lines can well remember the impression which it made upon him to hear Mr. Darwin gently complain that some of this warm enthusiasm for nature, as it presents itself unanalysed to ordinary healthy vision, seemed to be a little dulled in the younger naturalists of the day, who were apt to be somewhat cramped by the limits of their work-rooms. The pages of the "Journal of Researches" show no such restraint, but abound with passages in which Mr. Darwin's ever unstudied and simple language is carried by the force of warm impression and a perfect joy in nature to a level of singular beauty. One passage may be quoted as an illustration: it is from the description of Bahia in Chapter xxi.:—

"When quietly walking along the shady pathways, and admiring each successive view, I wished to find language to express my ideas. Epithet after epithet was found too weak to convey to those who have not visited the intertropical regions, the sensation of delight which the mind experiences. I have said that the plants in a hothouse fail to communicate a just idea of the vegetation, yet I must recur to it. The land is one great wild, untidy, luxuriant hothouse, made by Nature for herself, but taken possession of by man, who has studded it with gay houses and formal gardens. How great would be the desire in every admirer of nature to behold, if such were possible, the scenery of another planet! Yet to every person in Europe, it may be truly said, that at the distance of only a few degrees from his native soil, the glories of another world are opened to him. In my last walk I stopped again and again to gaze on these beauties, and endeavoured to fix in my mind for ever, an impression which at the time I knew sooner or later must fail. The form of the orange-tree, the cocoa-nut, the palm, the mango, the tree-fern, the banana, will remain clear and separate; but the thousand beauties which unite these into one perfect scene must fade away; yet they will leave, like a tale heard in childhood, a picture full of indistinct, but most beautiful figures."

A spirit such as this, penetrating an intelligence such as Mr. Darwin's, would not content itself with the superficial interest of form and colour. These, in his eyes, were the outward and visible signs of the inner *arcana*. The fascination of sense which the former imposed upon him but stimulated his desire to unveil the latter. In the Galapagos we are not then surprised to find him ardently absorbed in the problems which the extraordinary distribution of the plants, no less than of other organisms, presented:—

"I indiscriminately collected everything in flower on the different islands, and fortunately kept my collections separate."

After tabulating the results which they yielded after systematic determination, he proceeds:

"Hence we have the truly wonderful fact, that in James Island, of the thirty-eight Galapageian plants, or those found in no other part of the world, thirty are exclusively confined to this one island; and in Albemarle Island, of the twenty-six aboriginal Galapageian plants, twenty-two are confined to this one island, that is, only four are known to grow on the other islands of the Archipelago; and so on, as shown in the above table, with the plants from Chatham and Charles Island."

It is impossible in reading the Origin of Species not to perceive how deeply Mr. Darwin had been impressed by the problems presented by such singularities of plant distribution as he met with in the Galapagos. And of such problems up to the time of its publication no intelligible explanation had seemed possible. Sir Joseph Hooker had indeed prepared the ground by bringing into prominence, in numerous important papers, the no less striking phenomena which were presented when the vegetation of large areas came to be analysed and compared. No one therefore could estimate more justly what Mr. Darwin did for those who worked in this field. How the whole matter stood after the publication of the Origin of Species cannot be better estimated than from the summary of the position contained in Sir Joseph Hooker's recent address to the Geographical Section of the meeting of the British Association at York.

"Before the publication of the doctrine of the origin of species by variation and natural selection, all reasoning on their distribution was in subordination to the idea that these were permanent and special creations; just as, before it was shown that species were often older than the islands and mountains they inhabited, naturalists had to make their theories accord with the idea that all migration took place under existing conditions of land and sea. Hitherto the modes of dispersion of species, genera, and families had been traced, but the origin of representative species, genera, and families, remained an enigma; these could be explained only by the supposition that the localities where they occurred presented conditions so similar that they favoured the creation of similar organisms which failed to account for representation occurring in

---

[1] Continued from p. 100.

the far more numerous cases where there is no discoverable similarity of physical conditions, and of their not occurring in places where the conditions are similar. Now under the theory of modification of species after migration and isolation, their representation in distant localities is only a question of time, and changed physical conditions. In fact, as Mr. Darwin well sums up, all the leading facts of distribution are clearly explicable under this theory; such as the multiplication of new forms, the importance of barriers in forming and separating zoological and botanical provinces; the concentration of related species in the same area; the linking together under different latitudes of the inhabitants of the plains and mountains, of the forests, marshes, and deserts, and the linking of these with the extinct beings which formerly inhabited the same areas; and the fact of different forms of life occurring in areas having nearly the same physical conditions."

If Mr. Darwin had done no more than this in the botanical field he would have left an indelible mark on the progress of botanical science. But the consideration of the various questions which the problem of the Origin of Species presented led him into other inquiries in which the results were scarcely less important. The key-note of a whole series of his writings is struck by the words with which the eighth chapter of the Origin of Species commences:—

"The view generally entertained by naturalists is that species, when intercrossed, have been specially endowed with the quality of sterility, in order to prevent the confusion of all organic forms."

The examination of this principle necessarily obliged him to make a profound study of the conditions and limits of sterility. The results embodied in his well-known papers on dimorphic and trimorphic plants afforded an absolutely conclusive proof that sterility was not inseparably tied up with specific divergence. But the question is handled in the most judicial way, and when the reader of the chapter on hybridism arrives at the concluding words in which Mr. Darwin declares that on this ground "there is no fundamental distinction between species and varieties," he finds himself in much the same intellectual position as is produced by the Q.E.D. at the end of a geometrical demonstration.

It was characteristic of Mr. Darwin's method to follow up on its own account, as completely as possible, when opportunity presented, any side issue which had been raised apparently incidentally in other discussions. Indeed it was never possible to guess what amount of evidence Mr. Darwin had in reserve behind the few words which marked a mere step in an argument. It was this practice of bringing out from time to time the contents of his unseen treasure-house which affords some insight into the scientific energy of his later years, at first sight so inexplicably prolific. Many of his works published during that period may be properly regarded in the light of excursuses on particular points of his great theory. The researches on the sexual phenomena of heterostyled plants, alluded to above, which were communicated to the Linnean Society in a series of papers ranging over the years 1862-8, ultimately found their complete development in the volume "On the Different Forms of Flowers or Plants of the same Species," published in 1877. In the same way, the statement in the Origin of Species, that "the crossing of forms only slightly differentiated, favours the vigour and fertility of their offspring," finds its complete expansion in "The Effects of Cross and Self-Fertilisation in the Vegetable Kingdom," published in 1876.

The "Origin of Species" in the form in which it has become a classic in scientific literature was originally only intended as a preliminary *précis* of a vast accumulation of facts and arguments which the author had collected. It was intended to be but the precursor of a series of works in which all the evidence was to be methodically set out and discussed. Of this vast undertaking only one, the "Variation of Plants and Animals under Domestication" was ever actually published. Apart from its primary purpose it produced a profound impression, especially on botanists. This was partly due to the undeniable force of the argument from analogy stated in a sentence in the introduction:—"Man may be said to have been trying an experiment on a gigantic scale; and it is an experiment which nature, during the long lapse of time has incessantly tried." But it was still more due to the unexpected use of the vast body of apparently trivial facts and observations which Mr. Darwin with astonishing industry had disinterred from weekly journals and ephemeral publications of all sorts and unexpectedly forced into his service. Like Molière's Monsieur Jourdain, who was delighted to find that he had been unwittingly talking prose all his life, horticulturists who had unconsciously moulded plants almost at their will at the impulse of taste or profit were at once amazed and charmed to find that they had been doing scientific work and helping to establish a great theory. The criticism of practical men, at once most tenacious and difficult to meet, was disarmed; these found themselves hoist with their own petard. Nor was this all. The exclusive province of science was in biological phenomena for ever broken down; every one whose avocations in life had to do with the rearing or use of living things, found himself a party to the "experiment on a gigantic scale," which had been going on ever since the human race withdrew for their own ends plants or animals from the feral and brought them into the domesticated state.

Mr. Darwin with characteristic modesty had probably underrated the effect which the "Origin of Species" would have as an argumentative statement of his views. It probably ultimately seemed to him unnecessary to submit to the labour of methodising the vast accumulations which he had doubtless made for the second and third instalments of the detailed exposition of the evidence which he had promised. As was hinted at the commencement of this article, his attention was rather drawn away from the study of evidence already at the disposal of those who cared to digest and weigh it to the exploration of the field of nature with the new and penetrating instrument of research which he had forged. Something too must be credited to the intense delight which he felt in investigating the phenomena of living things. But he doubtless saw that the work to be done was to show how morphological and physiological complexity found its explanation from the principle of natural selection. This is the idea which is ever dominant. Thus he concludes his work on climbing plants:—"It has often been vaguely asserted that plants are distinguished from animals by not having the powers of movement. It should rather be said that plants acquire and display this power only when it is of some advantage to them; this being of comparatively rare occurrence, as they are affixed to the ground, and food is brought to them by the air and rain." The diversity of the power of movement in plants naturally engaged his attention, and the last but one of his works—in some respects perhaps the most remarkable of them—was devoted to showing that these could be regarded as derived from a single fundamental property. "All the parts or organs of every plant while they continue to grow . . . are continually circumnutating." Whether this masterly conception of the unity of what has hitherto seemed a chaos of unrelated phenomena will be sustained time alone will show. But no one can doubt the importance of what Mr. Darwin has done in showing that for the future the phenomena of plant movement can and indeed must be studied from a single point of view.

Along another line of work Mr. Darwin occupied himself with showing what aid could be given by the principle of natural selection in explaining the extraordinary variety of detail in plant morphology. The fact that cross-fertilisation was an advantage, was the key with which, as indicated in the pages of the "Origin of Species," the bizarre complexities of orchid flowers could be unlocked. The detailed facts were set out in a well-known work, and the principle is now generally accepted with regard to flowers generally. The work on insectivorous plants gave the results of an exploration similar in its object and bringing under one common physiological point of view a variety of the most diverse and most remarkable modifications of leaf-form.

In the beginning of this article the attempt has already been made to do justice to the mark Mr. Darwin has left on the modern study of geographical botany (and that implies a corresponding influence on physio-palæontology). To measure the influence which he has had on any other branches of botany, it is sufficient to quote again from the "Origin of Species":—"The structure of each part of each species, for whatever purpose used, will be the sum of the many inherited changes, through which that species has passed during its successive adaptations to changed habits and conditions of life." These words may almost be said to be the key-note of Sachs's well-known text-book, which is regarded as the most authoritative modern exposition of the facts and principles of plant-structure and function. And there is probably not a botanical class-room or work-room in the civilised world, where they are not the animating principle of both instruction and research.

Notwithstanding the extent and variety of his botanical work, Mr. Darwin always disclaimed any right to be regarded as a botanist. He turned his attention to plants doubtless because they were convenient objects for studying organic phenomena in their least complicated forms; and this point of view, which if one may use the expression without disrespect, had something of the amateur about it, was in itself of the greatest importance. For, from not being, till he took up any point, familiar with the literature bearing on it, his mind was absolutely free from any prepossession. He was never afraid of his facts or of framing any hypothesis, however startling, which seemed to explain them. However much weight he attributed to inheritance as a factor in organic phenomena, tradition went for nothing in studying them. In any one else such an attitude would have produced much work that was crude and rash. But Mr. Darwin—if one may venture on language which will strike no one who had conversed with him as overstrained—seemed by gentle persuasion to have penetrated the reserve of nature which baffles smaller men. In other words, his long experience had given him a kind of instinctive insight into the method of attack of any biological problem, however unfamiliar to him, and he rigidly controlled the fertility of his mind in hypothetical explanations by the no less fertility of ingeniously-devised experiment. Whatever he touched he was sure to draw from it something that it had never before yielded, and he was wholly free from that familiarity which comes to the professed student in every branch of science, and blinds the mental eye to the significance of things which are overlooked because always in view.

The simplicity of Mr. Darwin's character pervaded his whole method of work. Alphonse de Candolle visited him in 1880 and felt the impression of this. "He was not one of those who would construct a palace to lodge a laboratory. I sought out the greenhouse in which so many admirable experiments had been made on hybrids. It contained nothing but a vine." There was no affectation in this. Mr. Darwin provided himself with every resource which the methods of the day or the mechanical ingenuity of his sons could supply, and when it had served its purpose it was discarded. Nor had he any prepossession in favour of one kind of scientific work more than another. His scientific temperament was thoroughly catholic and sympathetic to anything which was not a mere regrinding of old scientific dry bones. He would show his visitors an *Epipactis* which for years came up in the middle of a gravel walk with almost as much interest as some new point which he had made out on a piece of work actually in hand. And though he had long abandoned any active interest in systematic work, only a few months before his death he had arranged to provide funds for the preparation of the new edition of Steudel's Nomenclator, which, at his earnest wish, has been projected at Kew.

(*To be continued.*)

MASCART AND JOUBERT'S "ELECTRICITY AND MAGNETISM"

Leçons sur L'Électricité et la Magnetisme. Par E. Mascart et J. Joubert. Tome I. (Paris, 1882.)

MANY of our readers must already be familiar with the "Électricité Statique" of M. Mascart. They will therefore turn with high expectations to the perusal of the "Leçons sur l'Électricité et le Magnétisme," of which he is one of the authors. On the whole they will not be disappointed. They will find in it all the limpid clearness, all the vivacity, all the elegance of presentation, both spiritual and material, that characterise the best French text books; and they will find withal none of the shallowness with which their grudging admirers have been wont to credit them. It is a wonderful national gift that our Gallic neighbours have—their power of scientific exposition. We Britons, with a stray exception, are far behind them; still farther are our German cousins. Notwithstanding our undoubted kinship in language and descent with the Germans, and all our well-founded appreciation of their excellence, we weary of their very virtues. One turns from their copious Gründlichkeit, as from the indispensable *labour* of life, and one finds in the reading of a good French text-book a never-failing *pleasure.*

Only the first volume of the Leçons is as yet before us, and some of our criticisms may have, on that account, to be taken with allowance; for the head, however important, is not the whole body. We see at once that there is little in common between them and the "Électricité Statique;" the plan of the work, so far as it has gone, is quite different. It originated, so the preface tells us, in the lectures of one of the authors at the Collège de France. The first volume is general and theoretical; the second is to be special and practical. As to the propriety of such an arrangement, much depends on the class of students to which it is addressed. If it is meant for such as have already a considerable knowledge of electrical phenomena, and some practice in accurately conceiving and describing them, then the plan is good. If, on the other hand, the reader is supposed to be a beginner in electrical science, knowing nothing of the phenomena, but furnished merely with the requisite mathematical knowledge, then we do not think well of it. We prefer in that case, the arrangement of the "Electricité Statique," that is, a fuller account of the phenomena upon which the fundamental principles rest, with a mathematical treatment sufficient to prevent vagueness of impression, and thereafter a detailed deductive account of the consequences of the fundamental principles, and a full description of the phenomena irrespective of their agreement or disagreement with theory. Assuming that we have to deal with a student, who has the first element of a physicist, viz. a tolerable mathematical education, perhaps the greatest danger to be avoided is formalism, or blind swearing, *in verba magistri.* Nothing is more likely to encourage this, than hurried and hasty discussion of fundamental facts. Nothing in reality is gained by driving the learner express to the law of the inverse square, and then leisurely expounding its consequences. Far better, that we should first secure for him a thorough qualitative understanding of the natural phenomena; and then teach him how they can be built together upon an abstract frame-work, whose lines they will follow, not necessarily with absolute coincidence. The learner must be taught at the very outset that analysis is the servant and not the master of the physicist; and that a physical idea is not always simplified by clothing it in an analytical suit of buckram. This much as a warning to possible students of this volume.

With one feature of the plan of these Leçons we must express unqualified satisfaction; that is the adoption of the methods of Thomson and Maxwell. At times these are so closely followed that the paragraphs are little more than translation; at other times considerable changes, chiefly in the way of simplification, are introduced. At the same time, the authors have not scrupled to borrow from other sources, where good material was to be had. They have gone on the principle of Molière, "je prends mon bien où je le trouve"; and rightly, for scientific light (unlike political or theological), is not supposed to be the property of one sect or one country. The English reader will not find much that is new, or perhaps we should say not accessible to him in his own language, however much he may learn as to arrangement and demonstration. Originality apparently is not aimed at; the authors put before their readers such of the modern development of electrical theory as they deem most important in themselves, or most likely to be useful to the physicist. We are of opinion that their selection on the whole has been judicious; and therein lies the chief merit of the book. It will, therefore, fill a great gap in French scientific literature. Possibly the second volume may help to fill the corresponding gap in the experimental part of the subject, which exists, unfortunately, in English as much as in French literature.[1] How urgently such treatises are wanted, and how ignorant one nation may be of what is common-place to another, is well exemplified by the fact that a distinguished *savant* like Prof. Clausius lately published, both in *Wiedemann's Annalen* and in the *Philosophical Magazine*, as something new and noteworthy, the theorem of mutual potential energy and certain consequences therefrom, that have been familiar to us ever since we knew anything of electrical theory, *i.e.* some ten years or more.[2]

We are thus led to notice the one serious defect of this treatise—the entire want of all references to original sources of information. These Leçons can have been meant only for those that contemplate a special study of electricity or original work of some kind bearing upon it; for such learners knowledge at first hand in some degree is essential; and who is to lead the scientific sheep to the water-springs if their responsible shepherds do not? We are well aware, from bitter experience, of the drudgery involved in this part of book-making, and of the difficulty, with all care, of being absolutely accurate and just; but utter neglect of the duty is inexcusable. Here is a provoking instance. The reader is aware that there are two different ways of representing the action of a mass of polarised molecules:—First, by a volume and a surface-distribution of attracting centres; second, by a surface distribution alone. The first of these is undoubtedly due to Poisson. The second is continually used in German books, and attributed to Gauss (the first method, and Poisson with it, they mostly ignore). Now MM. Mascart and Joubert add to the diversity by quoting the second method as Poisson's. It is certainly news to be told that Poisson knew of any such general theorem, and a cursory re-examination of his memoirs failed to find it. Until the exact reference is given, we must hold our previous conviction that the theorem in question was virtually first given by Green in his essay on "Electricity and Magnetism" (Nottingham, 1828). It was discovered independently by Gauss, whose statement of it (the first explicit one) is given in Art. 2, "Intensitas Vis Magneticæ, &c.," read December, 1832, to the Royal Society of Göttingen. His demonstration is given in Art. 36 of the "Allgemeine Lehrsätze, &c." Again, the corollaries from Gauss' Theorem of Mutual Potential Energy in Art.

---

[1] The Germans have the admirable treatise of Wiedemann, which, in its forthcoming shape, with electrostatics added, will be the greatest experimental treatise on electricity in existence.

[2] The theorem is simply a particular discrete form of Green's theorem; and in this shape was originally given by Gauss in his "Allgemeine Lehrsätze, &c." In one point of view it is simply a property of homogeneous functions of the second degree, and plays a part in many branches of mathematics, *e.g.* curves and surfaces of the second degree, theoretical dynamics, strains and stresses, &c.

63 *may* have been originally drawn by M. Bertrand; but, as no reference is given, we cannot meantime be sure whether his claim is any better than that of Clausius.

Detailed analysis being clearly out of place here, we conclude with a few running comments on the different parts of the work. The first part deals with Electrostatical Phenomena. Except that we think the introductory chapter somewhat hurried and meagre, we commend the general simplicity of the arrangement. A quasi-physical proof of most of the general propositions concerning electrified systems is given, and, we think, in the interest of the physical reader, that this is right. The seventh chapter of this part is especially recommended to the notice of our readers; there, so far as we know for the first time, Sir W. Thomson's theory of dielectrics finds its place in a text-book on Electrostatics; both here and in the corresponding chapters on Magnetism the authors show a complete appreciation and mastery of this important step in mathematical physics. Until Maxwell's treatise was written, this piece of Thomson's work had been apparently forgotten. It has lately been taken up in Germany, more especially by Helmholtz *more suo.* This neglect is no doubt to be explained by the equal neglect of the ideas of Faraday, of which Thomson's theory is the mathematical embodiment. The errors one occasionally finds on this subject in continental text-books of authority are very surprising, *e.g.* it will be found stated that a small sphere of magnetic or diamagnetic substance tends to move *along the lines of force;* the better diffusion of the true theory will surely tend to prevent such fundamental mistakes as this. The application of Thomson's theory to dielectrics is most interesting and important theoretically; but great difficulty has been found in verifying it experimentally, owing to the scarcity of bodies that will insulate sufficiently well. Its application to magnetics has been most successful, as our readers doubtless know.

The second part treats of electric currents, stationary and variable, and will probably be found well suited for the higher class of practical electricians; the account of the theory of telegraphic signalling deserves special mention. In Chapter II. of this part the authors are more cautious as to Volta's law of contact than they are at the end of the former part, knowing doubtless, as sound practicians, that they are on delicate ground.

The theory of magnetism, which constitutes the third part, suffers, as did the electrostatics, in the beginning, from the suppression of experimental detail. We cannot reconcile ourselves to the definition given of the magnetic axis as the line joining the poles of the magnet. This seems a very artificial and difficult way of introducing this fundamental conception; and we do not see the advantage over the ordinary method, which defines it as that direction which is always found parallel to a certain fixed vertical plane when the magnet is suspended freely under the earth's action alone at a given time and place. We also fail to see why, in mentioning the hypotheses advanced to explain terrestrial magnetism, Gilbert and Biot should be mentioned, and Halley and Hansteen forgotten. In other respects, this part of the work gives as good an account of its subject as most treatises we have seen. Our readers may note the discussion of the direct magnetic action of the heavenly bodies as something fresh in a text-book.

The last part of the work deals with Electro-magnetism. The connection between a current and the equivalent magnetic shell is deduced in a very ingenious (although we scarcely think simple) way from the law of Biot and Savart. The other method, which we prefer, is also given, in which the elementary proposition is that a plane circuit, whose linear dimensions are infinitely small compared with the distance of the point at which its action is considered may be replaced by a small magnet. A separate chapter is very properly given to the Methods of Ampère, and the authors have shown their judgment in refraining from loading their pages with the various solutions of the indeterminate problem to find the elementary law of electrodynamic action of which we have lately had a superfluity. An excellent account is given of the general theory of Maxwell. The only thing we would take objection to is yet another meaning given to that overburdened word Electromotive Force; the authors use *Force Electromotrice Totale* in place of Maxwell's *Vector Potential.* The deduction of the rotation of the plane of polarisation from Hall's phenomenon is given; but Prof. Rowland's name is not mentioned in connection with it; although we are under the impression that it was first given by him in the *American Journal of Mathematics.*

In a supplementary chapter some examples are given of the application to electrical phenomena of the principles of Carnot. Certain of these, due to M. Lippmann, are ranged under the somewhat high-sounding title of the Conservation of Electricity. We are a little inclined to question the propriety of this phrase; but we are certainly obliged to MM. Mascart and Joubert for a succinct account of what we are to understand by it.

We shall look with much interest for the second volume of this work, in which, among other things of interest to practical electricians, we are promised a discussion of the efficiency of electric generators and electromotors, a subject on which the recent experience of the authors at the Paris Exhibition must have well qualified them to give an opinion.

G. C.

OUR BOOK SHELF

Die Gasteropoden der Meeres-ablagerungen der ersten und zweiten miocänen mediterran-stufe in der Oesterreichisch—Ungarischen Monarchie. Von R. Hörnes und M. Auinger. Lieferung 1, 2, 3. (Vienna: Hölder, 1879-1882.)

A MERITORIOUS and useful contribution to our knowledge of the tertiaries of middle Europe. The first-named author is the worthy son of a worthy sire, the late Prof. Hörnes, whose work on the fossil shells of the Vienna Basin is so familiar to palæontologists. The total number of species hitherto described or noticed in the present publication is 220, including 94 new species or forms. Out of all this number 11 only are given as recent or living; and two more may be added (viz. *Nassa semistriata* and *Columbella corrugata* of Brocchi), which inhabit the Mediterranean as well as the North Atlantic. These recent species have survived from the Miocene epoch—a period of incalculably remote antiquity—without the slightest change. The rest may be regarded as the οἱ πλέονες in the same sense as we use euphemistically for our dead. Perhaps some more fossil species may be hereafter identified with living species when palæontologists work in unison with naturalists, or when conchologists become acquainted with both kinds of species. This is a great desideratum; and for want of it several eminent palæontologists (Nyst, Hörnes, and others) made regrettable mistakes in such identification, having been misled by names and not things. We may observe that Gastropoden, instead of Gasteropoden, is the more correct and usual spelling of the word. The plates, sixteen altogether, are admirably executed; and the publication does great credit to the Imperial Institute of Geology at Vienna.

J. GWYN JEFFREYS

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

The Winter of 1881-82

YOU have given some figures about the winter of 1881-82 in Great Britain. It was relatively much warmer here. The mean temperatures and its variation from average for November, 1881, to April, 1882, was:

	Nov.	Dec.	Jan.	Feb.	March.	April.
Mean	32·0	23·2	29·5	25·0	31·5	38·2
Diff. from average	+2·7	+3·1	+14·5	+8·4	+8·0	+3·1

The general character of these months is thus a very decided high temperature. That of January was the warmest on record in the 130 years' observation. If we take the mean of the three months, January, February, and March, it is also the highest on record, viz., 28·7; the other years in which these three months had the highest temperature were: 1822, 28.1; 1863, 27·4; 1843, 26·9; 1794, 26·6. The temperature of the five months, November to March, viz, 28·2 in 1881-82, was surpassed only once, in 1821-22, 29·3; the other years when these months were warmest are: 1842-43, 27·6; 1761-69, 27·1; and 1826-27, 26·9.

The Neva was frozen less than four months, while on the average the ice lasts nearly five months (147 days), and in the winter of 1880-81 the river was frozen 184 days, the longest time on record since the observations began, that is, for about 175 years. The date of opening of the river this year, March 30, is the earliest, except that of 1822 (March 18).

The last winter is, besides, noticeable for its deficiency of snow, there being scarcely ten days of fair sleighing. The precipitation of the months from November to March was 1″·9 less than the average, that of December alone by 0″·8, that is, by nearly two-thirds. Besides, a large part of it fell as rain. On account of the want of snow, the rivers had not their ordinary spring floods, and great quantities of timber, prepared to be floated for the use of St. Petersburg, could not be moved.

On the middle and lower Wolga, the snowfall of last winter was excessive, and even Taschkent and the valley of Ferghana, in Central Asia (lat. 40°-42°), had an exceedingly cold winter, with permanent and deep snow. The winter was also very cold in Transcaucasia, the minimum temperature in November, 1881, being lower than ever observed before in Tiflis.

St. Petersburg, May 27 A. WOEIKOF

The Mean Temperature of the Atmosphere at the Surface of the Earth as Determined by Observations and by Theory

WHEN several people, not knowing each other, arrive at the same results, the one by compilation and computation of observations, the others by theory, these results present a good probability of correctness, and the theory involved ought to be of interest to science.

In NATURE, vol. xxv. p. 395, I read—"The temperature of the southern hemisphere has lately been investigated by Dr. Hann with the aid of recent observations of temperature in high southern latitudes, especially those made during the Venus transit in 1874. For mean temperature of the whole atmosphere he obtains 15°·4 C., and as that of the northern hemisphere was estimated by Ferrel to be 15°·3 C., it is very probable that both hemispheres have the same mean temperature. Dr. Hann, however, also shows that between 40° and 45° south latitude, the southern hemisphere becomes warmer than the northern in the same latitude, and that a difference between the two persists at least to the confines of the hypothetical antarctic continent. . . ."

In "On some Properties of the Earth," 1880 (Wertheimer and Lea, publ.) occur the following passages, founded on and connected by theory alone (p. 95):—"We thus find the average temperature of the atmosphere at the surface of the earth to be 20° C., the isotherms of 20° C. having in their mean the parallels of 30° for basis; this figure, obtained by reasoning, is confirmed by isothermal maps. We will see *why the* 20° *are lowered to* 15°·22 *C., the true mean temperature of the atmosphere at the surface of the earth*."

And on pp. 123 to 126: "The line of greatest heat is in the mean moved $\frac{1}{29·78}+\frac{1}{175}$ of the sphere, or 3° 58′+4′ latitude, north of the equator. Temperature is therefore in a compressed or higher state in the lower latitudes of the north." . . .

"Inside the isotherms with the parallels 38° 58′ as basis, the temperature of the north is in excess over that of the south. This isotherm of the mean atmospheric temperature reaches over sea so far north as to embrace those seas which may be called the Mediterranean . . . it reaches on land to 47° 50′-3° 56′, where the temperature of Genoa in 43° 51′ N. lat. is 15°·7 C., and that of Alais 44° 10′ N. lat. is 15°·4 C. Beyond this isotherm, or beyond the bases of 38° 58′ lat., the difference between north and south decreases [which implies that the temperature at the south gets gradually warmer than at the north, chiefly in longitudes examined by Dr. Hann]. . . . At the isotherms of 1°·666 C., of which that at the south is quite maritime, and almost without curving, the equilibrium of temperature between south and north is re-established, the isotherms coincide, each in its mean, in both hemispheres, with their parallels or bases, they divide the hemispheres in proportion 1 : 4·78 . . ."

O. REICHENBACH

Sea-shore Alluvion—the "Chesil"

GREATER attention and speculation have been bestowed on this than any other of our marine littoral moles, the Transactions of various societies abounding in papers describing it, and as the westernmost of our south coast beaches, within the limits of the narrow seas, may well terminate a review thereof.

Leland, Camden, Lambarde, and Holinshed, all describe it, and how it fluctuates in quantity dependent on the wind. Leland used the word "Chesil" (which became a proper name as applied to this particular bank) as a general term, descriptive of shingle banks, throughout his work. Lilly, who wrote in 1715, describes it most accurately. Hutchins calls it "Steepstone," and derives its name from "Ceorl," the Saxon for gravel. Gough adopts the same derivation, calling it "a prodigious heap of pebbles thrown up by the sea, beginning at Chesilton, in Portland, and reaching beyond Swyre, 16⅔ miles."

The most remarkable feature is the top "full" about fifteen feet above the lower ones at the Portland end forming a huge seaward wall or mole, exceeding anything of the kind to be seen along our coasts, the land-slope of which is flat. At the east end it is thirty to forty feet above high water of springs, gradually lowering westward, and the stones decreasing in size. The land-locked tidal lake, the "Fleet," between it and the main, is another feature so common to these formations; it terminates opposite the valley to Abbotsbury, down which runs a small mill-stream. Between Lord Ilchester's castle and the Abbotsbury Coastguard Station the great beach ceases, the bight terminating in low tertiary cliffs, which intercept the top "full," the lower "fulls" continuing of an average height, as at Deal and elsewhere; two to three miles west of Abbotsbury the beach is thrown up into very sharp slopes, which, from the fineness of the material, become very solid, and continues to decrease in size and altitude, intercepted by the cliffs at Burton, and again formed into a moderate "full" on each side of Bridport harbour. The great elevation attained by the eastern end of this bank, where it abuts against the Island of Portland, exhibits an exceptional accumulation of water-driven material in the hollow of, and to the north-east of the Great West Bay, which bears, with seamen, the ugly name of "Dead Man's Bay," from an embayed vessel caught in a south-west gale seldom escaping shipwreck. More than half a century back, Fleet was inundated from a breach in the beach, and the church washed down, and many houses in Chesilton destroyed.

It is said locally, that the material is so finely graduated, that a native boatman or fisherman can tell in the darkest night the exact locality his boat may come ashore or be beached on, by picking up a handful of the gravel. In a south-west gale it is next to impossible to stand on the eastern crest, from the rain of pebbles projected over its summit by the breaking waves.

The Chesil is shown with great accuracy in early manuscript maps, especially in a remarkable series of drawings collected by the great Cecil, well known at the British Museum as "Lord Burleigh's Book;" also in drawings by Collins and Lilly. From these it would appear, that two or three centuries back the "Fleet" was wider, leading to the inference that the beach had retreated landward; but a close inspection of the bank does not support this conclusion, but appears to show that the surplus material is driven in heavy weather right over the crest sloping towards the "Fleet," the area of which has been narrowed and reduced by this continued process.

The gradation of material here again shows the ultimate leeward movement from west to east, due to preponderance of winds from the first quarter; the altitude from three to four times that of the normal elevation of ordinary English beaches above high water; also the upper plateau above the usual neap and spring "fulls" are striking features, showing its abnormal character.

The largest shingle travelling to leeward and to the summit, is illustrative of the accumulative energy of the heavier projectiles, and their being less acted on by the recoil than the smaller materials.

It may be well to notice here the soundings taken in H.M.S. *Beagle*, between Santa Cruz and the Falkland Islands, referred to by the late Mr. Darwin in his work "Geological Observations," published in 1876, and which he truly describes as presenting the usual phenomena in such cases. The material quickly and regularly decreasing in size with increased depth and distance from shore, under two miles out large and small pebbles were found intermixed.

Miles.	Depth, fathoms.	
At 2 to 4	11 to 12	Pebbles size of walnuts and smaller.
4 to 7	17 to 19	Do. size of hazel nuts.
10 to 11	23 to 25	$\frac{3}{10}''$ to $\frac{4}{10}''$ ms. diameter.
12	30 to 40	$\frac{2}{10}''$ diameter.
22 to 150	45 to 65	$\frac{1}{10}''$ do. to fine sand.

This is confirmatory of, or supported by, observations around our own coasts.

J. B. REDMAN

6, Queen Anne's Gate, Westminster, S.W., June 10

Meteor

ON Wednesday, June 7, 9 45 p.m. G.M.T., at a station 396 yards north-west by west of the transit-circle of the observatory, Mr. W. H. Robinson's attention was attracted by the sudden appearance of a fine meteor about 3° below Mars, which passed through a point 5° below Regulus, and, continuing its course about 12° further, finally disappeared. Almost instantly after being first seen, it shone very brightly, then assumed a train of detached luminous beads, and towards the end of its path burst, presenting an appearance similar to the bursting of a rocket. Its greatest brilliancy was equal to Venus. The length of the whole track was about 25°, and the time of visibility of the train was about five seconds.

E. J. STONE

Radcliffe Observatory, Oxford, June 8

Earthquakes in Naples

THE seismographs of the Vesuvian Observatory and of the Naples University have shown increased activity the last two days. This culminated this morning at 6.47 a.m. in a distinct shock seven seconds duration, direction north to south, chiefly undulatory, but elevatory towards the end. From these facts Prof. Palmieri considered it to come from a distance, and not of local origin. This was proved by telegrams from Isurnia and Vinchiaturo in the Apennines. All to-day the amount of vapour from Vesuvius is much more abundant, and this evening it is brilliant; the quantity of lava flowing is increased. This is a good example on a small scale of seismic activity having its focus in a mountain chain affecting the neighbouring volcanoes.

Naples, June 6

H. J. JOHNSTON-LAVIS

THE "POLYPHEMUS"

HER MAJESTY'S ship *Polyphemus*, which has been five years under construction, is now being prepared for her final trials. She contains so many peculiarities of design and novelties of various kinds in her machinery and fittings that much scientific interest attaches to her performances. Her form is different from that of any other ship ever built. The part above water has been described as resembling a cylinder floating on its side and deeply immersed, which is tapered at the ends to form a bow and stern. An idea of her appearance above water may be obtained by imagining such a cylinder to be flattened over a large portion of its area to form a deck, and to float at a height of 4 feet 6 inches out of water. The whole of the exposed part of this surface, which has great curvature near the water line, and enters the water at an angle of about 45 degrees, is plated over with steel armour, which is carried some distance below water. The curvature of the sides is continued to a depth of several feet below the water line, and from this point they turn sharply in and converge towards each other at the keel almost in straight lines. A cross section of the vessel is similar to a pegtop, which is floating in water at a depth below its greatest breadth, and the emersed part of which presents a convex surface only. Upon this form of hull an iron superstructure is mounted, which carries a hurricane deck from which the ship is worked, and to which the openings into the main body of the ship are carried up. Two protected coverings are fitted on this deck, one at each end, which are connected with the structure of the hull, and give means of communication with the interior. There are three revolving turrets on each side, which are each armed with one of the heaviest Nordenfelt guns. This superstructure may all be shot away without injuring the vessel or impairing her powers, except as regards the use of the Nordenfelt guns.

The lines of the ship are very fine, and have been determined chiefly with a view to great speed. The armour plating is very light; no heavy guns are carried; many devices have been adopted to reduce the weight of the machinery; and some of the main fighting qualities of most other men-of-war have been sacrificed, in order that a high speed may be realised. The speed she was designed for is 17 knots; although with the great amount of horse-power; for her size, she is intended to indicate, a higher speed might be expected if it is efficiently utilised. The offensive weapons of the *Polyphemus* consist of the ram and torpedo. She will carry no guns except six Nordenfelt machine-guns, which will each be carried in a projecting turret at the height of the flying deck. These will serve to repel boat attack; but for offensive operations against powerful vessels, she will only be able to employ the ram and torpedoes. The successful use of these weapons will depend primarily upon speed. High speed is essential, to prevent failure in ramming; and in using torpedoes under heavy gun-fire, it is very important to be able to approach an enemy quickly, and to get away again with all possible celerity, as the contingencies of this mode of fighting may require. The efficiency of the *Polyphemus* thus being a question of speed, it will be understood why so many sacrifices have been made in order to enhance this quality. The vessel has been constructed as light as possible throughout, and saving of weight has been carried to a great extent.

The hull is built of mild steel; the frames being of Bessemer, and the bottom plating of Landore-Siemens steel. There is a double bottom, and the hold of the ship is largely divided into separate watertight compart ments by means of bulkheads. A longitudinal bulkhead is fitted at the middle line; the boilers are contained in four separate water-tight compartments; the engines in two; and the coal bunkers are also water-tight.

The engines and boilers are manufactured by Messrs. Humphreys and Co. There are two pairs of engines working twin screws. They are of the horizontal compound type, the cylinders of each pair being 38 inches and 64 inches in diameter, and the stroke 39 inches. They are intended to indicate an aggregate horse power of 5500. These engines are remarkable for their lightness and the comparatively small space they occupy. Most of their novel features have been adopted for the purpose of economising weight and space. They are almost entirely of wrought iron, Whitworth steel, and gun-metal; very little cast iron being used in their construction. The screws are three-bladed, and are 14 feet in diameter, with 15 feet to 17 feet pitch. The shafts are left bare where they come outside the hull of the ship, and are not surrounded by tubes, as is usual in ships of the Navy. These tubes have been dispensed with for the purpose of diminishing the resistance. The boilers are of the locomotive type; and these also were adopted in preference to the ordinary marine boiler, for the purpose of saving weight and space. They are 5 feet 3 inches in diameter, and 14 feet 4 inches in length, and work with a steam pressure of 120 tons per square inch. The shells are of steel, the fire-boxes of iron, and tubes of brass; and they are similar to ordinary locomotive boilers, except that the tubes are shorter and the fire wells less deep. The stoke-holds are closed in, and forced draught is worked with, as in the fast torpedo boats. This is supplied by four fans, two of which are 4 feet and the other two 3 feet 6 inches in diameter. The fan engines have 9-inch cylinders, and 4½ inches stroke, and run at the rate of 900 to 1000 revolutions per minute when working at full speed.

The trials of the machinery have, so far, not been successful, chiefly on account of difficulties with the boilers. During the first series of trials, on March 2, 4, and 6 last, nothing could be done on account of priming. The greatest speed realised was 10 to 12 knots, when the boilers primed so badly that a stop had to be come to. On March 31 there was another trial, the last down to the present time, when the difficulties of priming were mainly got over. The indicated horse-power on that occasion was about 5000, and the speed a little over 17 knots. The air-pressure in the stoke-holds, which gave the forced draught, was equivalent to 5 inches of water. On this occasion the boiler-tubes leaked very badly, so that the full power could not be realised. The priming was due to oil from the engines getting into the boilers, and this now appears to be remedied. In the torpedo boats that are fitted with locomotive boilers, the same difficulty arises, and oil is not used at all in the cylinders, or only very sparingly. The leaking of the tubes is a more serious difficulty to get over, although in the *Polyphemus* the arrangements appear to admit of improvement. For instance, solid iron stays were fitted in the midst of the brass tubes; and it must be obvious that the unequal rate of expansion of the stays and tubes when heated to a high temperature must have considerably strained the tube plates. These stays are now being removed, and new tubes are being fitted throughout, the ends of which are to be screwed into the tube plates.

This difficulty of leaky tubes is not peculiar to the *Polyphemus*. Messrs. Thornycroft are in the same position with a large number of torpedo boats they have completed for the British Government, and which are undergoing a similar ordeal of testing by the Admiralty engineers. These boilers cannot be got to stand satisfactorily, and a number of experiments have just been carried out at Portsmouth upon tubes fitted in various ways in a torpedo boat boiler, which, it is hoped, will show how the present defects can be remedied. Locomotive boilers are not adapted for working continuously at a high rate, and for steaming at full speed over long distances. The strain put upon the boiler, and the work attempted to be got out of it, is too great under these circumstances. What is being done in the *Polyphemus* and in the torpedo boats, is to get the advantage of the lightness of this type of boilers; and only to press them up to their full power for comparatively short times when required in an emergency.

The armour plating is of steel; and here again we find an attempt to combine great defensive power with extreme lightness. It extends over the whole of the above water-portion of the hull, and for a short distance below the water-line. There are first two half-inch thicknesses of Landore-Siemens steel, upon which are placed plates of Whitworth fluid-compressed steel, one inch thick. Outside of this is another layer of hard Whitworth steel, one inch thick, which is tested to a strain of sixty-eight tons per square inch. This outer layer is fitted in small plates or scales ten inches square, secured with coned steel screw bolts, one at the centre of each of the plates, and one at each of the corners. Along the middle of the turtle-back deck these scales are omitted, and the armour is there only 2 inches thick. The bases of the trunks from the hatchways to the flying deck are protected by a glacis of 6-inch steel armour to a height of 3 feet 6 inches above the deck; and the front of the foremost trunk is plated to a height of about 5 feet above the flying deck, with 8 inches of steel-faced armour, which gives protection to the pilot tower.

The armament, as has been stated, merely consists of six Nordenfelt machine-guns, which are each mounted in a revolving turret that projects from the side of the flying deck. The fighting weapons she possesses are the ram and torpedoes. The former is very long and strongly constructed. It is, however, interfered with by a tube for ejecting torpedoes right ahead, which is fixed in the centre of the ram. This seems a doubtful expedient to adopt, and to endanger to some extent both the ram and the torpedo-tube. The bow has been made so as to protect this tube as much as possible. The torpedo armament consists of the tube referred to for ejecting torpedoes right ahead, and of two tubes on each side, also placed under water, in a compartment at the fore side of the boiler-rooms. In this torpedo compartment one tube on each side is fixed right abeam, and the other in the direction of about 20 degrees at the fore side of the beam. There is only means of firing one torpedo end on, the other four tubes being on the broadside. It is questionable as to the merits of this arrangement, considering that the end-on position will be the one for attacking from in the *Polyphemus*, for the purpose of using the ram, and also to enable the greatest possible resistance to be got out of her thin armour. Independent air-compressing machinery for the torpedoes is carried in each of the torpedo-chambers, in which also a number of torpedoes will be carried ready for use.

The height of the hull proper above the water line is, as we have said, 4 feet 6 inches. It is kept low to reduce the chances of penetration; but to furnish more buoyancy than this small freeboard gives, a strange device has been adopted. At the keel of the ship a deep rectangular recess is made in which about 300 tons of iron ballast is carried. This ballast is so fixed that it can be let go at pleasure, and the ship lightened accordingly. The draught and trim may thus be regulated to some extent should the ship be injured in action. If the whole of the ballast is let go it will lighten her about 14 inches.

As manœuvring power is of great importance to such a vessel as the *Polyphemus*, an attempt is made to increase it by means of bow rudders. Two of the rudders, of the balanced form, are placed forward, one on each side of the bow torpedo tube. They can be drawn up into apertures inside the hull when not required for use; and when working they may be coupled up with the engine working the stern rudder, and all three rudders worked together. The dead wood has been cut away aft to a large extent in order to reduce the resistance to turning.

DOUBLE STARS

SOME stars when looked at in a telescope are seen really to consist of two stars so near together that the naked eye is not able to distinguish them, but sees them as a single star.[1] The knowledge of some of these objects may be presumed to be almost as old as the telescope. In fact Hevel remarked some of them in the middle of the seventeenth century, but no attention was paid to them, as it was thought that they were really far asunder in space, and merely appeared close together in the heavens, because they were nearly in the same visual ray. It thus escaped notice that one star frequently moves round the other, and Lambert, as late as 1761, founded his opinion that those fixed stars that appear near others, were in no physical connection with them, upon this absence of relative motion, because, as he says in his "Cosmologische Briefe," if they do not move round each other, and still gravitate towards each other, they must long ago have collapsed. But a few years after the Rev. John Michell applied the rules of the calculation of probabilities to the stars in the Pleiades, and showed that it was exceedingly improbable that these stars could appear so near together, if their proximity was the result of a random scattering of the stars over the heavens, and he showed that among 40,000 stars, one could expect to find only one pair within twelve seconds of arc of each other, and none nearer. These speculations were, however wholly conjectural, as long as no proper observations were available, and it was therefore to the purpose when the highly merited Jesuit, Christian Mayer, of the observatory at Mannheim, founded by the Elector of Pfalz, commenced to search for, and systematically to observe, double stars. But he met with no support from his contemporaries, and had to defend his opinions in several polemical pamphlets. His instrument, a mural quadrant by Bird, was scarcely sufficient for the purpose, and his opinion, that, "satellites" of the brighter fixed stars were found at a distance of as much as three degrees, was certainly wrong in the instances he adduced, though Mädler has shown that stars as far asunder may possibly be physically connected.[2] We must, therefore, consider William Herschel to be the first who proved the existence of double stars. This he did by aid of micrometric measures,[3] which he originally had made with the view of finding the parallax of fixed stars, similar observations having previously been attempted by the Rev. Roger Long, of Pembroke College, Cambridge, who, however, had not been very successful.

Herschel commenced micrometric measures in 1776, when he observed θ Orionis. In 1779 he began systematically to search for and measure double stars, and as early as 1782 he laid his first "Catalogue of Double Stars" before the Royal Society. It contained 269 objects, but few of which had been observed by Chr. Mayer. Subsequently he published other catalogues, which, however, contain many stars more than 32″ asunder, which are not now considered as double stars proper; but of the latter Herschel discovered between four and five hundred. He measured double stars micrometrically up to 1785, and again for some years after 1790. The measures showed some discrepancies, but it was impossible to decide whether the relative motion of the components—for changed their position some of them evidently had—was rectilinear or otherwise, and whether it in some cases perhaps arose from the proper motion of one star. However, already in 1794 Herschel explained how they must move in curved paths on account of their mutual gravitation, and in 1803 appeared that famous "account of the changes that have happened during the last twenty-five years in the relative situation of double stars," in which he, from actual measures, proved this to be a fact. But Continental astronomers were nevertheless slow to give in to so novel and startling a revelation. In France even Lalande openly expressed his want of faith in these disclosures, notwithstanding his high regard for Herschel's merits in other respects.—At the end of his active career Herschel had the pleasure to see his son John Herschel take up this subject with fervour. South, the friend of this illustrious astronomer, joined him in this work, and obtained thus a place in the scientific world, to which his own merits, only for this connection would scarcely have entitled him. J. Herschel went in 1834 to the Cape of Good Hope, where he discovered and made some measures of above two thousand double stars on the southern sky with his 20-feet reflecting telescope. He continued to take an active interest in these stars till his death in 1871, when he left behind unfinished manuscripts that showed that he had been engaged on a general catalogue of double stars and the observations made of them. It contained about 10,000 entries.

FIG I.

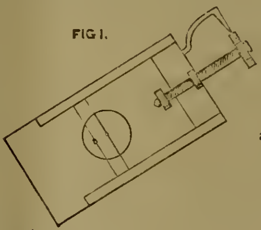
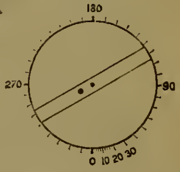


FIG 2.



Meantime Struve in Russia had commenced a series of double-star measures, which is even now unsurpassed, as well with regard to extent as to consistency. In 1824 he received a 10-inch refractor, mounted equatorially, from Fraunhofer of Munich, and with this magnificent instru-

---

[1] Mizar and Alcor, the "test-star," in the great bear, present to the naked eye very much the same appearance as a double star does, when seen in a telescope. Their distance is about a lunar radius. It is sometimes said that distances less than five minutes are not visible to the eye, but when wearing glasses I see ϵ Lyræ, the distance of whose components is less than four minutes, double.

[2] It was evidently Chr. Mayer's opinion that the smaller star shone in reflected light. The term "double star" had been applied by previous observers, who little dreamt that these stars would become so interesting.

[3] It may be as well to explain in a few words the instrument with which such minute quantities are measured. It is called a micrometer, and forms the eyepiece of a large telescope. It is well known that in the focus of the object-glass of a telescope, the image of the object contemplated appears inverted. Now in this focus are stretched two parallel spider lines, at least one of which is moveable by an extremely fine screw. The magnitude of the object or the distance between the two components of the double star are thus measured in revolutions or fractions of a revolution of this screw; for which purpose the head of the screw is divided into hundredths, the tenths of which are estimated by the eye (see Fig. 1). The value in seconds of arc of each revolution of the screw is either ascertained by measuring some known distance or by measuring the length of a revolution in parts of an inch (a very small quantity) and dividing this by the focal length of the object-glass expressed in inches. The value of a revolution is generally found to vary a little with the temperature, as the steel of which the screw is made expands or contracts with the heat, but this is counteracted by changes in the focal length of the object-glass. It is of more importance to examine the irregularities of the screw, the different turns of which might not exactly be of the same size. Even parts of each turn might be slightly different. However modern engineers have carried the making of screws on the lathe to so high a perfection, that there are screws made in which no errors can with certainty be ascertained. It also deserves to be remarked that it is more easy to make a screw accurate the finer it is.—But the screw gives us only the distance of one star from the other. We require to know also in what direction it is situated. For this purpose the plate on which the micrometric screw and the wires are fixed can be revolved, and the wires placed parallel to the line joining the centres of the two stars. The angle is read off on a circle in firm connection with the tube. This, the so called angle of position is counted from the line connecting the principal star with the pole. From north 0° round through east 90°, south 180°, and west 270° (see Fig. 2). This circle is adjusted by allowing the stars in their daily motion to run from east to west along the wires. The index should then point to 90° or 270°. But it must be kept in view that the images are inverted, so that *e.g.* when looking southwards, north appears down.

ment he worked indefatigably for thirteen years, making above 10,000 measures; and it may be said that by this telescope the genius of its maker carried the palm on behalf of refractors in measuring minute quantities in the sky, while the reflectors stepped into the background, and were subsequently preferred only in cases where the definition is of less consequence than light-grasping power.[1] Struve not only made measures—thanks to Fraunhofer's excellent micrometer and his skill in handling it—more accurate than had been possible up to that time, but he also catalogued about 3000 double stars between the pole and fifteen degrees southern declination. He had their places exactly determined with Ertel's meridian-circle, and these observations, compared with those of later date, have in many cases established the fact that the proper motion was common for two stars, that revolved so slowly that no change in their relative position had been discovered by aid of the micrometer. Thus their physical connection is then established, but indeed "optical double stars" are so uncommon within the limits here considered, that the discovery of an optical couple is almost a greater curiosity. In such a case the micrometric measures serve to accurately fix the amount of the proper motion of one star, the other being generally so distant that it appears stationary, as well as to ascertain the parallax of the nearer star if perceptible. Struve also every night carefully noted the magnitude and colour of the stars he observed, and divided them into *Lucidæ* and *reliquæ*, according to whether the smallest star is above or below the eighth magnitude. According to their mutual distance, he divided them into eight classes, as follows:—

Class I.	Distances from	0″ to 1″	Class V.	Distances from	8″ to 12″
,, II.	,,	1 to 2	,, VI.	,,	12 to 16
,, III.	,,	2 to 4	,, VII.	,,	16 to 24
,, IV	,,	4 to 8	,, VIII.	,,	24 to 32

Struve's principal works are: "Stellarum duplicium et multiplicium mensuræ micrometricæ per magnum Fraunhoferi tubum annis a 1824 ad 1837 in Specula Dorpatensi institutæ," and "Stellarum fixarum imprimis compositarum positiones mediæ deductæ ex observationibus meridianis a 1822 ad 1843 in Specula Dorpatensi institutis."

Though Struve achieved his main results after the arrival of Fraunhofer's refractor, he had made double-star observations as early as 1814, but his apparatus were then so deficient, that he had to try to make use of differences of right ascension observed with a small transit instrument, an attempt that, in spite of his experience as an observer, could not but prove a failure. His observations were subsequently continued, under his direction, by his son, who, with the 14½-inch refractor at Pulkowa, discovered about 500 additional objects. He has made about 7000 measures during the last forty years, and thus we are in possession of observations continued during about seventy years by the Struves, after the same methods.

Meantime, similar investigations had made considerable progress elsewhere. In England, the subject was taken up by the Rev. W. R. Dawes, who, taking into consideration the smallness of his means, achieved more than any contemporary observer. He is justly considered one of the most distinguished of those amateur astronomers, to whom British science is so much indebted. He made about 2000 measures in all. Subsequently, Baron Dembowski, in Italy, commenced micrometric observations of double stars, and though the means originally at his disposal would have been wholly inadequate in other hands, the accuracy of his measures was about as great as that attained at more richly-furnished observatories. Pushed on by his success, he acquired larger and better instruments from Fraunhofer's successor at Munich, and entered upon a series of observations, in which he greatly surpassed the accuracy of other observers. It is therefore to be regretted that the mass of observations he accumulated during a quarter of a century, has not yet been more than partly laid before the public. Investigators were, however, expecting a volume that would completely embody Dembowski's work, when the mournful news of his death in January, 1881, spread over Europe. Compared to his observations, those made by Sir W. Herschel appear to be as rude as observations made before the invention of the telescope, compared to those of the nineteenth century.

It was in the course of the researches carried on by the latter observers, that circumstances came to light which have proved to be of the utmost importance. I allude to the existence of systematic errors. Already Struve found that he measured angles of position differently, when he inclined his head to either side, and he found that in any case, his distances were different from those given by other observers. He did not, however, follow up this remark, but merely kept his head straight while observing, and with regard to the distances he did not see how his own results could deviate from the truth; but his son, though he is in possession of such a great refractor, has been found to measure double stars altogether erroneously. This he has remedied by observing artificial double stars (white ivory disks on a black ground), and after applying the corrections thus ascertained to his measures on the sky, the accuracy of his results has been sensibly increased, though of course the circumstances attendant on such operations are very different from those under which astronomical observations are made during the night, *e.g.* the artificial double stars are always seen near the horizon and are stationary, while the stars are ever moving, and have to be followed by aid of a more or less deficient clockwork driving the telescope. Dawes also, found systematic errors in his measures. He tried to do away with them by slightly inclining his head when the stars were nearly in a vertical, and by the use of a prism, fixed before the eyepiece, to make them appear vertical, when the line joining their centres formed a great angle with the vertical. He says, in the introduction to his observations, that no one about to draw a straight line with a ruler would lay this crooked on the table; one prefers to lay it parallel to the line joining the two eyes. It is in fact most agreeable to measure a double star when the components are either nearly vertical or nearly horizontal. Dembowski's observations seem free from systematic errors, but with praiseworthy diligence he has thought fit to subject this circumstance to a minute scrutiny. To this end he was observing circumpolar double stars of different classes in every hour angle round the pole, as these errors have been found to depend upon not only the angle the line joining the stars makes with the line joining the eyes of the observer, but also on their mutual distance, and as the error diminishes quickly as this increases, it is recommended to use always the highest magnifying power which the state of the atmosphere and the quality of the object-glass will allow.

Space would not allow me to refer to all the astronomers, who at one time or another have paid attention to the subject, or to discuss the relative value of their work. Father Secchi made some good measures in Italy, Duner, in Sweden, has published about 3000 valuable observations, and Gledhill, in Halifax, has also successfully taken up this work. In spite of the skies of Connaught, that clear so seldom and so irregularly, I have tried to do my best, but I have not succeeded in getting

---

[1] The definition of an image seen in a large reflector is inferior to that in a smaller refractor, both on account of the greater influence of any defect in grinding the surface of a mirror, and because, when the aperture is larger, the rays of light from the object have to pass through so much larger a portion of the atmosphere, the irregularities and motions in which render the image unsteady and badly defined.

more than 1000 observations up to this. Latterly, this branch of science has made distinct advances in America, where Burnham has made excellent use of the gigantic refractors, which are made by Alvan Clark of Boston. He has discovered a number of important double stars, the components of which cannot be separated at all in older telescopes.[1]

In 1878 the French astronomer Flammarion, who is so favourably known from his excellent popular treatises, published his "Catalogue des Étoiles doubles et multiples en Mouvement relatif certain, comprenant toutes les Observations faites sur chaque couple depuis sa découverte, et les résultats conclus de l'Étude des mouvements," a work that is highly valued by double-star investigators, but private observers will do well in consulting also Messrs. Crossley, Gledhill, and Wilson's "Handbook of double-Stars," with its "Supplement."

As remarked above Herschel found that changes had taken place in several systems of double-stars, and in 1836 Struve was able to give a list of a hundred systems, where the components appeared to revolve; but on account of the difficulty of the measures, it was not easy to decide whether this was owing to actual motion of the star or in some cases to divergences of the observations. But he proved beyond dispute in about half the cases that the companion had revolved, and Mädler, who was one of the most indefatigable double-star observers, as well as the most prominent calculator, raised this number to several hundreds. His work, "Tabula generalis stellarum duplicium indicationem motus gyratorii exhibentium," was published in 1849, and contains 650 entries, but many of these were mere surmises, and have not been corroborated by subsequent research.

If the observations were absolutely free from errors, it would be an easy task to investigate the path of the companion, but in addition to the imperfection of every observed position, we have as explained above to guard against systematic differences between the different observers. In long series of observations of quickly revolving stars, this gives occasion to endless discussion. We draw, for instance, a powerful aid in discerning systematic errors, from Kepler's law, that the areas described by the radius vector are proportional to the intervals of time; but he would be a bold man, who in the present state of our knowledge, would affirm that all binary stars have been proved to revolve according to this law in elliptic orbits, in the focus of which the main star is situated,[2] or would condemn all observations that could not be made to fit into such an hypothesis. But though this assumption is a mere hypothesis, and may remain so for a long time to come, we have nothing else to guide us. In fact we cannot calculate an orbit at all except by aid of these laws.[3]

W. DOBERCK

(*To be continued.*)

---

[1] The difficulty of separating close double stars renders them fit tests for the performance of a telescope. Some idea of the quality of a telescope may be gained, when it is stated that it is able to separate objects of a certain class, be it *lucidæ* or *reliquæ*, but withal, it is preferable to try its performance on terrestrial test objects. A third sub class "delicate" double stars, or those in which the companion is so minute compared to the main star, as to require a high degree of optical power to perceive it, has been added by Sir John Herschel, but it deserves to be remarked that the appearance of such objects depends quite as much upon the state of the atmosphere. The companion of Sirius, for instance, has been repeatedly seen in 4-inch refractors under exceptionally favourable circumstances, though in a great latitude. A large aperture is therefore not always an advantage. The situation of the observatory is of much greater importance. Piazzi Smyth has the merit of having for years insisted upon this point. The Lick Observatory, about to be founded on Mount Hamilton, California, will offer unusual advantages. Mr. Burnham has there already discovered some difficult double stars with a minor telescope.

[2] Both stars revolve, of course, round their common centre of gravity, but it is easy to see that the *relative* position of the two stars is all the same then as if only one revolved. If the changes in the absolute place of one of the stars were known, we would have the means of computing the relative masses; but this has only been possible in a few cases at most.

[3] In case of certain triple stars, whose movements do not fit into Keplerian ellipses, we have to represent the motions by aid of epicycles, just in the same way as Ptolemæus represented the motion of the planets in the system named after him.

THE MARIANNE NORTH GALLERY OF PAINTINGS OF "PLANTS AND THEIR HOMES," ROYAL GARDENS, KEW

MANY readers of NATURE are doubtless aware that the large collection of beautiful and instructive pictures of flowers painted in various countries by Miss Marianne North, is now, through the noble generosity of this lady, the property of the nation. The collection is in a handsome building specially erected in Kew Gardens for the purpose, at Miss North's expense, and from designs given by Mr. James Ferguson, F.R.S. Last week the gallery was opened without any ceremony whatever, and henceforward it will be open and free to the public at the same times and hours as the museums and other buildings in the Gardens.

Now that this is an accomplished fact, a few words respecting the history and the principal features of the collection may be useful. Impelled by a love of nature, Miss North has spent many years travelling from country to country, and painting the most striking scenes and objects that came under her observation; and from time to time some of these paintings have been exhibited in London. The more Miss North travelled and painted, the more the desire to travel and paint seems to have grown; the result being a large collection of pictures. Then arose the question, what should be done with them? and happily in this Miss North was influenced by the kindly feeling that she would like other less fortunate persons to see and enjoy what she herself had seen and enjoyed so much. This idea once conceived, the warm-hearted artist and traveller set to work more assiduously than before, in order to carry it into effect, even visiting Australia and New Zealand, for the purpose of painting the vegetation of that region. In a country where the love of flowers is general from the poorest to the richest, such a gift as that now offered to the public will assuredly be fully appreciated.

The collection is designated in the title of the catalogue as paintings of "plants and their homes," and this title is justified by the fact, that in nearly all the pictures, plants have supplied the motive, the other objects represented being accessories. Altogether there are upwards of six hundred pictures, representing vegetation in nearly all temperate and tropical parts of the world except Europe and Africa, unless we regard Teneriffe as belonging to the latter country. A descriptive catalogue, compiled by the writer of this notice, and published at Miss North's expense, contains not only the titles of the pictures, but also short notes concerning the life-history, products, &c., of the plants painted, inserted with the intention of making it as instructive as possible to those who know least of such things. There are representations probably of not less than a thousand species, and these include members of nearly every natural order in the vegetable kingdom. The fruit and other useful plants of the different countries are numerous; and associated with them are many of the most ornamental and most striking wild and cultivated plants. In dealing with trees and shrubs, the artist has usually painted a flower-bearing or fruit-bearing branch, or both, in front, and given the habit of the tree or shrub in a landscape behind. Without being botanical, the paintings of the plants are so thoroughly naturalistic, that a botanist has little difficulty in determining such as are not known to him by sight. In so far as regards its prominent features and peculiar types, the Australian flora is more completely portrayed than any other, about seventy-five pictures being devoted to this region. Miss North visited Queensland, New South Wales, Victoria, Tasmania, South Australia, and West Australia; and from each of these colonies she brought home paintings of a large number of the most striking and characteristic plants. Thus of Eucalyptus there are portraits of *E* *amygdalina*, *calophylla*, *colossea*, *cordata*, *ficifolia*, *globulus*, *tetraptera*, and several others; of other characteristic Myrtaceæ, the genera Callistemon, Syncarpia, Agonis, Melaleuca, Beaufortia, and Leptospermum; of Leguminosæ, Acacia, Gompholobium, Kennedya, Clianthus, Platylobium, &c.; of Epacrideæ, Leucopogon, Richea, Epacris, Lissanthe, and Styphelia; of Proteaceæ, Banksia, Grevillea, Xylomelum, Telopea, Hakea, Lambertia, Macadamia, Petrophila, &c.; of genera belonging to other natural orders, taking them in the order they occur in the pictures: Phyllocladus, Doryphora, Casuarina, Pimelea, Prostanthera, Billardiera, Exocarpus, Anigozanthus, Xanthorrhæa, Kingia, Cephalotus, Cheiranthera, Xanthosia, Leschenaultia, Stylidium, Johnsonia, Trichinium, Isotoma, Byblis, Actinotus, Nuytsia, Doryanthes, Fusanus, Comespermum, &c., &c. In conclusion I may state that there is a complete index to the catalogue, so that it is possible to ascertain what plants are figured by reference thereto.

W. BOTTING HEMSLEY

AN ELECTRIC RAILWAY

THE following account of the electric railway of Breuil-en-Auge is taken from an article by M. Gaston Tissandier in our contemporary, *La Nature*. The subject of electric railways, which has recently claimed public attention; and the recent construction on a commercial scale of a practical electric railway in the department of Calvados in France derives additional interest from the fact that the motive power is, in this instance, furnished by electric accumulators. We propose to give a general description of the railway, but will first briefly state the object for which the line has been constructed.

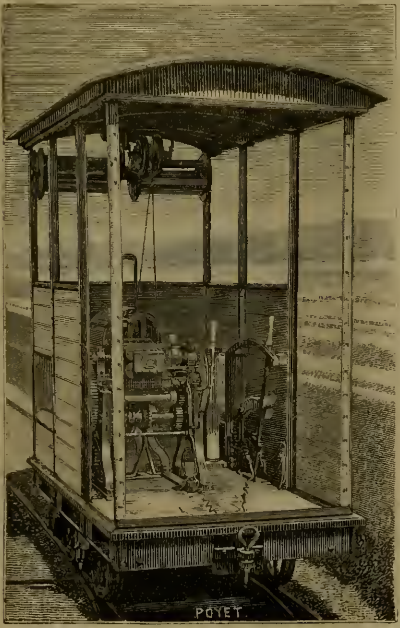


FIG. 1.—The locomotive, with dynamo-electric motor and driving-gear.

The linen-bleaching establishment of M. Paul Duchesne-Fournet is situated at Le Breuil-en-Auge, and is a large concern to which most of the linen fabrics manufactured at Lisieux are sent to be bleached. The complete process of bleaching consists in successively exposing the linen pieces first to the action of chlorine, then to alkaline baths, lastly to the sun's rays. The last operation is of course conducted out of doors by laying out the linen in the open meadows. Each length of linen measures about 100 metres, and the establishment boasts a bleaching ground of 15 hectares (37 acres). The operation of taking up the pieces is laborious, necessitating several workmen.

M. Clovis Dupuy, engineer-in-chief of the works, proposed a mechanical device for picking up the linen pieces by the aid of a railway which carried the requisite mechanism. But a railway worked by a steam-engine could not be tolerated in the bleaching field, as the smoke produced by the burning fuel and the ashes projected from the funnel would play havoc with the linen laid out beside the line. M. Dupuy therefore determined to build an electric railway, the construction of which is now finished, and which works very satisfactorily.

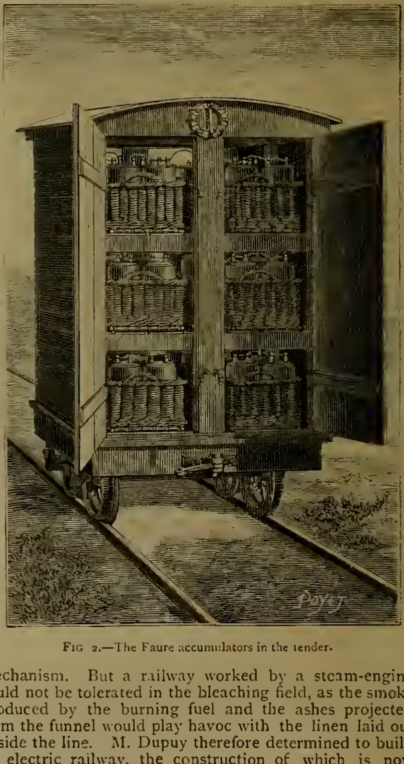


FIG 2.—The Faure accumulators in the tender.

The electric railway of Le Breuil-en-Auge passes the end of each of the many plots upon which the linen is laid out, there being a piece of straight line 500 metres in length, and twenty-one branch lines. The total length is 2040 metres. The rails are of the narrow gauge of 0·8 metre (2 feet 7½ inches).

The train is driven by a locomotive shown in Fig. 1, the driving machinery being a Siemens' dynamo-electric machine working as a motor. The currents to drive the motor are supplied from a battery of Faure accumulators contained in a separate tender, depicted in Fig. 2. The train starts from the factory with the wagons empty. Arrived at the bleach-field, it stops. By the movement of a handle, the motor is thrown into gear with a set of windlass rollers employed to wind up the linen. Passing between these rollers the linen ascends to another roller in the top of the car, which covers the machinery, where it passes to a workmen, who packs it in folds in a little truck (Fig. 3). Preferably all the linen pieces laid out upon the plot of neighbouring ground, are united to one another by their ends, so that a single workman can pick up 5000 metres of linen in thirty minutes, an operation usually requiring eleven hours to perform. Fig. 4 shows the train of little trucks returning loaded with 10,000 metres of linen. Having thus described the general system, it will be convenient to examine the details.

Fig 3.—Hauling in the bleached linen.

Fig. 4.—The return of the electric train from the bleaching ground.

The motor, or locomotive (Fig. 1) consists, as we have said, of a Siemens' dynamo capable of being reversed at will. The armature rotates very rapidly, the motion being reduced by a chain-gearing in the proportion of 1 to 9. A lever handle (see Figs. 1 and 5) controls the machine. As shown in Fig. 5, in a vertical position the brake is on, and no electrical action is taking place. By lowering the lever, contact is made, enabling the electric current to flow. A "rheostat-chain," the invention of M. Reynier, who in 1881 applied a similar device to a sewing machine driven by electricity at the Paris Exposition, is thereby stretched. As its tension increases, there is better contact electrically between its links, and with this better contact the electric resistance diminishes; the flow of current and consequently the speed of the engine, is therefore increased. By moving the lever in one direction or the other, the speed of the train may therefore be varied at will. When the lever is put back to its position of rest, it not only breaks contact, but also puts on the brake. To reverse the motion of the train, there is a second lever, which shifts the brushes of the dynamo. A third lever sets the wheels of the dynamo in gearing either with the axle of the locomotive, or with the hauling machinery previously mentioned.

The tender (Fig. 2) attached to the locomotive holds the accumulators, which are of the type constructed by M. Reynier, consisting of two lead plates covered with red lead, and wrapped in felt or serge, rolled together in a spiral, placed in dilute acid in a stoneware jar. These cells are arranged (Fig. 2) in three tiers in baskets, each basket holding six cells. On each shelf are four baskets, except on the uppermost, which holds two only. The sixty accumulators weigh 500 kilogrammes (half a ton).

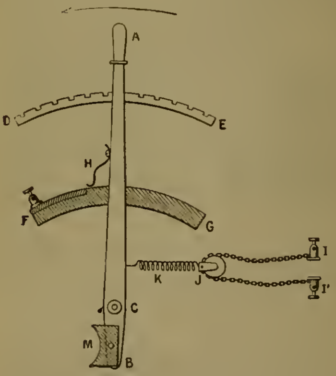


FIG. 5.—The starting-gear, with chain rheostat.

The total weight of the locomotive is less than a ton, that of the tender 700 kilos. (1543 lbs.), and that of each loaded truck 800 kilos. (1763 lbs.). With the workmen and six passengers, the total weight of the train is 6400 kilogrammes (about 6½ tons). The accumulator cells are charged at the factory by the current of a Gramme machine, which has been used since 1879 to light the establishment by eleven Reynier lamps. The power available in the works is 60-horse. Only 3 horse-power is, however, required during the charging of the cells, which takes from five to eight hours.

In the top of the tender is a switch, by means of which the accumulators can be used in rotation, beginning with a minimum of twenty-four, and increasing successively by sixes up to sixty cells.

This railway has worked since March last with results advantageous in every way. The speed of the train attains 12 kilometres (about 7½ miles) per hour; but in this special case, great speed is not desired. According to the information furnished by M. Dupuy, the train can work for three hours; being limited only by the charge that can be imparted to the accumulators.

This application of electricity to a purpose for which a steam-engine would be out of the question, is not only novel, but suggestive. We feel disposed to query how long it will be before that great section of the public of London who travel by the Metropolitan Railway, insist that their lungs and eyes have as much claim as the linen of M. Duchesne-Fournet to be protected from the disastrous presence of the smuts and scoriæ of the steam-engine.

THE WEATHER OF THE PAST WEEK

THE very disagreeable weather we have had these last few days deserves a passing notice. Strong persistent northerly winds for nearly a week have swept over the whole of the British islands. On Sunday and Monday a continuous north-easterly gale blew over Shetland and Orkney, completely interrupting all communication among these islands, accompanied with heavy rains, floods, and hailstorms; and at the same time much snow fell in the upland districts of the interior of North Britain, draping the mountains of Aberdeenshire and Perthshire in their winter covering of snow down nearly to their bases. On the other hand, in England and Scotland, much thunder and hail occurred towards the end of last week, and not a few lives were lost by the severity of the thunderstorms. These disagreeable and remarkable phenomena were attendants on an atmospheric depression signalled by the Meteorological Office on Thursday morning, last week, as about to advance over the more southern parts of these islands. The depression appeared in course, its centre following the line of the Cheviots; and its northern side being characterised by unwonted high pressures, it proceeded with singular leisureliness over the North Sea, and only reached Christiania by the morning of Monday. The slow onward rate of motion of this cyclone, the steep gradients formed on its north and north-west sides, and its southerly route across the North Sea readily explain the extent, strength, persistence, and disagreeably low temperature of the gale, and the unseasonable snowfalls which accompanied it. It is to such low depression-centres brooding over or slowly crossing the North Sea, that we owe our coldest summer weather; and it is a continued repetition of these in the critical months of June, July, and August that brings disaster to the farming interests. In the middle of June, 1869, a similar storm occurred when equally strong winds prevailed, when even more snow fell, particularly in the north-west of Great Britain, and temperature sank some degrees below freezing over extensive districts; but the storm was of shorter duration than the one we have just had. In this case, also, the cyclone formed steep gradients for northerly winds, and its centre crossed England and the North Sea, but it advanced over North-Western Europe at a more rapid rate than the present storm, which has formed so marked a feature of the weather of June, 1882.

NOTES

WE take the following from the *Times*:—At the meeting of the Royal Society last week, the fifteen undernamed candidates were elected Fellows:—Prof. Valentine Ball, M.A., George Stewardson Brady, M.D., F.L.S., George Buchanan, M.D., Charles Baron Clarke, M.A., F.L.S., Francis Darwin, M.A., F.L.S., Prof. William Dittmar, F.C.S., Walter Holbrook Gaskell, M.D., Richard Tetley Glazebrook, M.A., Frederic Ducane Godman, F.L.S., Prof. Jonathan Hutchinson, F.R.C.S., Prof. Archibald Liversidge, F.G.S., Prof. John C. Malet, M.A., William Davidson Niven, M.A., Robert Henry Inglis Palgrave, F.S.S., Walter Weldon, F.C.S.

IT is interesting to notice, that in connection with the vote of sympathy of the Common Council on the death of Garibaldi, the Lord Mayor stated that "on the death of the great philosopher and man of science, Mr. Darwin, he received over twenty telegrams from cities in Italy, expressive of Italian sympathy with the loss this country had sustained."

WE have received from Bucharest a little *brochure* of the greatest interest, in the shape of a translation into Roumanian of Sir John Lubbock's British Association address, "Fifty Years of Science," by Prof. J. P. Licherdopol. The translation, we learn from the title page, is made from the report in NATURE. Prefixed is a brief address to Sir John Lubbock, which is written in vigorous and almost perfect English. "Your 'Fifty Years of Science,'" the translator writes, "has impregnated itself in the heart of the people who populate the plains and mountains of the Lower Danube. The scientific truths and literary beauties of such a work of genius cannot remain unknown to the Roumanians; I therefore took upon myself the pleasing duty of making it more known among them. I beg of you, therefore, to glance at it, and to receive it as your own; you will recognise it, perhaps, by its forms, which are impossible to be changed." As the translator styles himself Professor of Natural History and Physical Science, ex-Assistant Naturalist to the Museum of Natural History, and preparator in the Chemical Laboratory; and as a list of other scientific works, original and translated, is prefixed, it is evident that science has a hopeful place in Roumanian education and literature.

A COMMITTEE of members of the Academy of Sciences, the Academy of Medicine, the Society of Agriculture, and the faculty of science in the Superior Normal School of Paris, has been formed for the purpose of presenting to M. Pasteur a medal in commemoration of his fruitful researches.

WE regret to announce the death of Mr. Scott Russell, the eminent engineer, which took place on Thursday morning last, in the seventy-fifth year of his age. John Scott Russell, according to *Engineering*, was the eldest son of the Rev. David Russell, a Scotch clergyman. His great predilection for mechanics and other natural sciences induced his father to allow him to enter a workshop, to learn the handicraft of the profession of an engineer. He subsequently studied at the Universities of Edinburgh, St. Andrews, and Glasgow, and graduated at the last at the early age of sixteen. He had attained to such proficiency in the knowledge of the natural sciences, that on the death of Sir John Leslie, Professor of Natural Philosophy in Edinburgh, in 1832, the young Scott Russell, though then only twenty-four years of age, was elected to fill the vacancy temporarily, pending the election of a permanent professor. About this time he commenced his famous researches into the nature of waves, with the view to improving the forms of vessels. His first paper on this subject was read before the British Association in 1835. The interest created by this paper was so great that a committee was appointed by the Association to carry on the experiments at their expense. Mr. Scott Russell discovered during these researches the existence of the wave of translation, and developed the wave-line system of construction of ships in connection with which his name is so widely known. In 1837 he read a paper before the Royal Society of Edinburgh, "On the Laws by which water opposes resistance to the motion of floating bodies." For this paper he received the large gold medal of the Society. In 1844 Mr. Scott Russell removed to London. In 1847 he was elected a Fellow of the Royal Society. He for a short time occupied the post of the secretary of the Society of Arts, which place he resigned to become joint secretary with Sir Stafford Northcote of the Great Exhibition of 1851. He was, in fact, one of the three original promoters of the Exhibition, and under the direction of the late Prince Consort, took a leading part in organising it. Mr. Scott Russell was for many years known as a shipbuilder on the Thames. The most important work he ever constructed was the *Great Eastern* steamship. Mr. Scott Russell was one of the earliest and most active advocates of ironclad men-of-war, and he has the merit of having been the joint designer of our first sea-going armoured frigate the *Warrior*. In early life he took a great interest in steam locomotion on ordinary roads, and while at Greenock he constructed a steam coach which ran for some time successfully between Greenock and Paisley. His greatest engineering work was without doubt the vast dome of the Vienna Exhibition of 1873. The last engineering work which Mr. Scott Russell ever designed was a high level bridge to cross the Thames below London-bridge. It was intended to cross the river with a span of 1000 feet, and to allow of a passage beneath it for the largest ships.

THE death is announced of Mr. James Spence, Professor of Surgery in Edinburgh University, in the 70th year of his age.

WE regret to announce the death of Dr. P. A. Bergsma, late director of the Batavia Observatory. He died on May 1, during his passage through the Red Sea, on the way home from India. We quite recently announced the retirement of Dr. Bergsma from his post in Batavia Observatory, where he has done so much good work.

IN anticipation of the jubilee meeting this year the *British Medical Journal* devotes most of its last number to a Historical Sketch of the British Medical Association.

AS a result of the action taken by the Essex Field Club with reference to the preservation of Epping Forest in its natural condition, a conference was held on Friday evening, June 9, at the residence of Mr. E. N. Buxton at Woodford. Of the verderers there were present besides Mr. Buxton, Sir T. Fowell Buxton, and Mr. Andrew Johnston. The scientific claims of those to whom the preservation of the forest as such is a matter of importance, were ably advocated by many well-known naturalists who had been invited to take part in the discussion. Among the speakers were Dr. Henry Woodward, Dr. M. C. Cooke, Mr. J. E. Harting, Mr. Charters White, the President of the Quekett Club, Mr. G. S. Boulger, and Messrs. R. Meldola and Wm. Cole, the President and Secretary of the Essex Field Club. The results of the conference were, as we learn, satisfactory with respect to the future of the forest.

THOSE entomologists who study fossil insects, and palæontologists generally, should feel grateful to Mr. S. H. Scudder for having compiled "A Bibliography of Fossil Insects," forming No. 13 of the "Bibliographical Contributions" appearing in the *Bulletin* of Harvard University. It extends (including an appendix) to 47 pages in double columns, and must include nearly 1000 references, to each of which, as a rule, are appended a few lines of explanatory notes. The subject is made to include spiders and myriopods, in addition to true insects. No trouble appears to have been spared in order to render it as complete as possible; on this point Mr. Scudder laments that the enormous increase of popular literature that has taken place latterly, containing hosts of minor papers wholly popular in character, has vastly increased the labour of compilation without corresponding advantage. He doubts if as much activity is now shown in the department of fossil entomology as when the labours of Heer gave a sudden impetus to its study. Possibly the often eminently unsatisfactory and speculative nature of the subject has something to do with this.

WITH reference to Prof. Riley's extracts from Dr. Macgowan's papers on the utilisation of Ants in Horticulture, in China, a correspondent calls our attention to a long article in the *Ceylon Observer* for April 26, in which is reprinted the following extract from Tennent's Natural History of that island:—"To check the ravages of the coffee bug (*Lecanium coffeæ*, Walker), which for some years past has devastated some of the plantations in Ceylon, the experiment was made of introducing the red ants, who feed greedily on the coccus. But the remedy threatened to be attended with some inconvenience, for the Malabar coolies, with bare and oiled skins, were so frequently and fiercely assaulted by the ants as to endanger their stay on the estates."

The *Rèvue Scientifique*, one of the most influential scientific periodicals in France, has been purchased by a company for the purpose of extending its publication and improving its programme.

On Tuesday evening Mr. Keane exhibited at the Anthropological Institute, on behalf of the finder, Mr. M. S. Valentine, of Richmond, Virginia, some very remarkable stone objects recently discovered by that archæologist in the neighbourhood of Mount Pisgah, North Carolina. In the course of his remarks Mr. Keane explained that these were merely a few typical specimens selected from an extensive collection of over 2000 articles, partly in stone and partly in micaceous clay found in this upland region, between the Alleghany and Blue Mountains, during the years 1879-82. The material of the stone objects is almost exclusively steatite, or soap-stone, which abounds in the district, and which might almost seem to have been sculptured with metal instruments, so perfect is the workmanship. The objects themselves are absolutely of a unique type, consisting partly of human and animal figures, either in the round or in various degrees of relief, partly of household utensils, such as cups, mugs, basins, dishes, and the like, partly of purely fancy, and other miscellaneous articles, illustrating the tastes, usages, and culture of the unknown people by whom they have been executed. Collectively they present, Mr. Keane maintains, a unique school of art developed at some remote period in a region where the presence of civilised men had not hitherto been even suspected. The human type, which presents great uniformity, while still by no means conventional, is distinctly non-Indian, according to Mr. Keane, but whether Mongolic or Caucasic it would at present be premature to decide. All are represented as fully clothed, not in the hairy blanket of the Red Man, but in a close-fitting well-made dress somewhat after the modern "united garment" fashion. Some are seated in armchairs exactly resembling those known as "Ingestre Chairs," while others are mounted on the animals, which they had domesticated. These animals themselves are stated to be marvellously executed. Some of them represent the bear, the prairie dog, and other quadrupeds, as well as birds of North America. But others seem to represent types of the Old World, such as the two-humped Baktrian camel, the rhinoceros, hippopotamus, and European dog. There are also some specimens obviously executed since the appearance of the white man, as shown by the horse with his rider, firearms, shoes, &c. The material of all these has a much fresher look than the others, and is of much ruder workmanship, as if they were the work of the present race of Indians. These races are undoubtedly of the pure Indian type, Mr. Keane stated, and recognised themselves as intruders in this region, where they had certainly been preceded by more civilised peoples, such as the Mound-builders and others, of whom they had traditions, and whom they had extirpated long before the arrival of the Europeans. Amongst these extinct peoples were the Allegs or Alleghewis, whose name survives in the "Alleghany Mountains." These Alleghewis are said to have been a different race from the Indian, and it is possible, Mr. Keane thought, that in their new homes in the Alleghany uplands they may have continued or developed the culture of which we have met remarkable evidence in these stone objects. It is evident, however, that before any conclusions can be built on this interesting find, the conditions under which it was found must be carefully sifted by archæological specialists.

The Municipal Council of Paris has voted the funds for executing six aëronautical ascents on the occasion of the festivities of July 14 next. Two of these balloons will be connected by a telephone wire in order to keep up constant verbal communications. These two connected balloons will ascend from the Place du Trone. It is hoped that by sending up balloons so connected many interesting observations can be made for the velocity of sounds at different altitudes, the differences of temperature of velocity of wind and of direction, &c., as well as differences of electrical tension.

During the progress of some excavations on Lord Normanton's estate, near Crowland, Peterborough, the workmen have exposed about three acres of a subterranean forest 10 feet below the surface. Some of the trees are in an admirable state of preservation, and one gigantic oak measures 18 yards in length. The trees are in such a condition that oak can be distinguished from elm, while a kind of fir tree seems to be most abundant, the wood of which is so hard that the trees can be drawn out of the clay in their entirety. The surrounding clay contains large quantities of the remains of lower animal life.

The working of subterranean telegraphic lines is stated to be unsatisfactory in France and in Germany as well, and it is doubted whether the process shall be continued in France, although credits have been voted by the French Parliament for a sum of several millions of francs. These circumstances ought to be carefully investigated, as it is contemplated, we understand, to introduce the continental subterraneous method into this country.

M. Cochery, the French Minister of Postal Telegraphy, has decided that the electrical laboratory established with the proceeds of the late Electrical Exhibition will be placed in the Bois de Boulogne. The reason alleged is the necessity of avoiding the shaking of the ground by the passing of carriages so frequent in Paris. The establishment will be open to the public under certain limitations and regulations, which will be printed in the *Journal Officiel*. The development of the institution will be only gradual, the profits realised amounting to only 300,000 francs, and the total sum required to 1,000,000 francs.

The works of the French Company for the Channel Tunnel are progressing favourably. A number of workmen are engaged in mounting the engine designed by Col. Beaumont, which is placed in the lower gallery, and will be in working order in a few weeks. The boring will be executed under the supervision of an English foreman, who conducted the excavation of the first 500 metres on the English side.

From the Report of the Mitchell Library, Glasgow, it seems evident that it is in a fair way of becoming one of the first libraries in the kingdom; the avowed aim of its trustees is to make it for Glasgow what the British Museum Library is for London. It contains already 40,000 volumes, a large proportion of which are scientific. The number of works taken out during the year in "Art, Science, and Natural History" (a curious classification), bore a large proportion to those on other subjects.

Mr. Joseph Simmons, the balloonist, made a journey on Saturday in his balloon the *Colonel* from Maldon in Essex, across the Channel to beyond Arras in France, a distance of 170 miles, in one hour and three-quarters.

A peculiar and interesting auroral phenomenon, witnessed from the steamship *Atlantic* off the Newfoundland coast, on

September 12 last year, has been described by Mr. Eogler to the St. Louis Academy. While an aurora of normal type was clearly seen in the northern sky, there appeared in the south-east, about 30 to 35 deg. above the horizon two horizontal streaks of light, about 5 deg. apart, and 15 or 20 deg. in length. Their pale hazy light resembled moonlight. From the upper streak were suspended, by small cords of light, a number of balls, brighter than either of the streaks, which were continually jumping up and down in vertical lines, much like pith-balls when charged with electricity. Above the upper streak was a bright gauze space with convergent sides, seemingly composed of streamers of light, the brightness diminishing from the streak outwards. From the lower streak extended a similar mass, differing only in a greater inclination of the streamers. The balls and cords gradually disappeared first, then the streamers, then the streaks; and the whole phenomenon lasted about half an hour. No explanation is offered. It is noteworthy that on the same evening and at the same hour, a most remarkable band of white light was seen at Albany, N.Y., Utica, N.Y., Hanover, N.H., Boston, Mass., and elsewhere in the North Atlantic States, spanning the heavens from east to west near the zenith.

THE sixth part of the *Transactions* of the Cumberland Association for the Advancement of Literature and Science, is a volume of 180 pp., and comprises the annual reports of the different local societies, amalgamated under the title, with a selection of papers read before the Association and the local societies. We have already given full details of the formation and working of the Association. The report of the secretary, Mr. J. D. Kendall, F.G.S., is encouraging, showing, that though there is a slight falling off in the number of members, due to the cause already noticed, there are now 1811 on the books. The present volume of *Transactions* is one of the most valuable the Association has yet published. It is divided into two parts, the first containing the President's address and the papers read at the annual meeting, and the second consisting of papers communicated to the different societies, and recommended by the Council for publication. Among the papers are—Public water-supplies of West Cumberland, by Mr. A. Kitchin, F.C.S.; Grasses of Mid-Cumberland, by Mr. W. Hodgson; Observations on the flowering-plants of West Cumberland, by Mr. J. Adair; the lichens of Cumberland, by Rev. W. Johnston; Notes on the occurrence of the Iceland falcon in Edenside, by Mr. J. G. Goodchild, accompanied by an excellent drawing of the bird; and Physical geography of North-West Cumberland, by Mr. T. V. Holmes. The second part includes an historical sketch, "The Chaloners Lords of the Manor of St. Bees," by Mr. W. Jackson, F.S.A., and an exceedingly interesting paper on bird-life, by Dr. Chas. A. Parker. Mr. Holmes contributes notes on a submerged forest off Cardurnock, on the Solway, and on the destruction of Skinburness by the sea about the year 1305. A valuable list of West Cumberland flowering-plants and ferns, by members of the Botanical Section of the Whitehaven Society, records the observed plants of the district. This appears to be the most complete list that has yet been published, though a few errors have crept in. The concluding paper is on the distribution of the Diatomaceæ, by Mr. B. Taylor, and consists of a list of the species obtained by him in the locality.

IN reference to Mr. S. M. Baird Gemmill's letter on the Aurora (*antea*, p. 105), the writer asks us to state that the aurora was observed on May 15th (not the 18th).

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albogularis* ♂) from West Africa, presented by Mr. Ballantine Dykes; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Mrs. Wingfield; a Yellow-bellied Liothrix (*Liothrix luteus*) from India, presented by Miss Mabel Crosbie; two Common Nightingales (*Daulias luscinia*), a Blackcap Warbler (*Sylvia atricapilla*), British, presented by Mr. H. Grant; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. David Rowell; a Common Nightingale (*Daulias luscinia*), British, two Yellow-bellied Liothrix (*Liothrix luteus*) from India, deposited; two Wood Larks (*Alauda arborea*), European, received in exchange; two Japanese Deer (*Cervus sika* ♂ ♂), two Mouflons (*Ovis musimon* ♂ ♂), a Cape Buffalo (*Bubalus caffer* ♂), born in the Gardens. The following insects have emerged during the past week:—Silk Moths: *Samia cecropia, Attacus mylitta, Attacus cynthia, Actias selene*; Butterflies: *Lycæna iolas, Limenitis sibylla, Argynnis paphia, Vanessa urticæ, Papilio podalirius*; Moths: *Sphinx pinastri, Chærocampa elpenor, Sesia formicæformis, Sesia conopiformis, Sesia muscæformis, Trochilium apiforme, Trochilium melanocephalum, Sciapteron tabaniforme, Callimorpha dominula, Odonestis potatoria.*

OUR ASTRONOMICAL COLUMN

MASKELYNE'S VALUE OF THE SOLAR PARALLAX.—Several inquiries have been lately made with regard to the authenticity of a value of the sun's parallax, attributed in many works to Maskelyne, the former Astronomer-Royal.

This value (8″·723) was deduced by Maskelyne in an application of what he calls a new method of determining the effect of parallax on transits of the inferior planets, and is given in an article which he appears to have communicated to Vince, Plumian Professor of Astronomy at Cambridge, who published it both in his large work, "A Complete System of Astronomy," and in his elementary treatise intended for the use of students in the University. We have not been able to consult the earlier editions of these works, to ascertain whether, as is probably the case, the article was published in Maskelyne's life-time, but it is found in Vol. I. of the "System of Astronomy," which appeared in 1814, and is dedicated to Maskelyne, and also in the fourth edition of the "Elements of Astronomy," Cambridge, 1816. The article is entitled "A new method of computing the effect of parallax, in accelerating or retarding the time of the beginning or end of a transit of Venus or Mercury over the sun's disc, by Nevil Maskelyne, D.D., F.R.S., and Astronomer-Royal." After explaining his method and how an approximate value may be corrected, as a numerical example he compares the duration of the transit of Venus in 1769 as observed at Wardhus and Otaheite, assuming as an approximate value of the mean horizontal parallax 8″·83 (nearly that found by Du Sejour), and concludes: "Hence the mean horizontal parallax of the sun = 8″·83 × (1 − 0·0121) = 8″·72316." In the "Elements of Astronomy" there is the additional sentence: "we assume, therefore, the mean horizontal parallax of the sun = 8¾″"; but this does not appear in Vince's larger work, nor is it quite clear whether it is an addition of Maskelyne's or his own."

Lalande says the first edition of Vince's "Elements of Astronomy" was published in 1790, and Vol. I. of the large work in 1797. Probably some of our readers may be able to refer to the earlier editions.

COMET 1882*a* (WELLS, MARCH 17).—The following ephemeris of this comet is deduced from the elements last given in this column:—

At Greenwich Midnight

	R.A.	Decl.	Log. distance from	
	h. m. s.	° ′	Earth.	Sun.
July 1	9 35 58	+11 57·0	0·0501	9·8925
3	9 50 49	11 23·2	0·0673	9·9205
5	10 4 21	10 50·2	0·0850	9·9461
7	10 16 43	10 18·2	0·1027	9·9697
9	10 28 2	9 47·4	0·1202	9·9916
11	10 38 26	9 17·9	0·1375	0·0120
13	10 48 1	8 49·6	0·1545	0·0310
15	10 56 54	+ 8 22·4	0·1711	0·0489

On July 1, the comet sets 1h. 44m. after the sun at Greenwich, and the theoretical intensity of light is equal to that on May 16; on July 15, it sets 1h. 50m. after the sun, with a brightness equal to that on April 19.

On June 7, Mr. Barber of Spondon, Derby, observed the comet with his 8-inch refractor, at 8h. 30m., or less than ten minutes after sunset: there was a large white disc, but no tail was visible at this time.

A SUSPECTED VARIABLE STAR.—Mr. S. M. B. Gemmill writes from Glasgow, expressing the opinion that ϕ Draconis will prove to be a variable star. For some time past he has observed it to be almost equal to χ in the same constellation, whereas Groombridge and others had given a difference of one magnitude. The "Durchmusterung" has 4·7 and 3·8 for these stars respectively, and the first Radcliffe catalogue, for which the magnitudes were very carefully estimated, has 4·4 and 3·7. Heis assigns a difference of half a magnitude. Mr. Gemmill states he has found a very slight fluctuation in ψ^1 Draconis, which seems to be periodic. Baily, in his notes to the *British Catalogue*, says: "This star is marked as of the 7th magnitude in the *British Catalogue;* but in the original entries it is designated once as 4½, once as 3½, and once as the 5th."

THE UNIVERSITY OBSERVATORY, OXFORD.—The Savilian Professor of Astronomy, director of the University Observatory, has issued his annual report, which was presented to the Board of Visitors on the 1st inst. It is mentioned that a somewhat elaborate memoir is now printed in the *Transactions* of the Royal Astronomical Society on the application of photography to delicate celestial measurement. The inquiry into the relative motions of some forty stars in the Pleiades has been brought to a successful conclusion, the results agreeing generally with those recently deduced by M. Wolf, of the Observatory at Paris, who employed a very different instrument and method. A complete survey of the relative brightness or magnitudes of all the stars in the northern hemisphere reputed to be visible to the naked eye has been commenced, and it is hoped that before the date of the next report, all the stars brighter than the fifth magnitude, some five hundred in number, will have been measured. The report touches also upon the discordances between the observed degree of brightness of Comet 1882 *a*, with the results deduced from theory. The expenditure for the purposes of the Observatory, has, it is stated been under the amount provided by Convocation; a sum of 600*l.* per annum is available for three years from December last, and this the Savilian Professor considers will probably suffice for the future efficient maintenance of the Observatory, the only difficulty that might arise relating to necessary repairs, &c., of the present instruments, or the addition of new ones that may be needed.

GEOGRAPHICAL NOTES

M. LESSAR's paper on his excursion from Askabad to Saraks (*Izvestia*, vol. xviii. fasc. 2) will be read with pleasure by those who are interested in the topography, inhabitants, and social conditions of this country. With regard to natural science, we notice the result of the levelling which was made along the line of the Transcaspian railway; it proved, that contrary to what was presumed, the country does not have a general slope from east to west. At the Aïdin wells there are several places situated below the present level of the Caspian, and all the tract between this place and the present shore of the Caspian—M. Lessar states—cannot be regarded as the former bed of a river; it was probably the bottom of a very large gulf of the Caspian, which extended towards the east. It is most probable—he adds—that a levelling between the Tekke oasis and Khiva or Bokhara, will also show in the sand-steppes many tracts situated below the level of the Caspian, as has been found in the Sara-kamysh depression; and it will prove that the Murghal and Tejent could not flow into the Oxus, but flowed into the Caspian, much extended at that time towards the east. We notice in the same paper a remark with regard to termites; their hemispherical moulds, one to two feet in diameter, are very numerous in certain localities; numberless galleries are discovered under these moulds, which galleries are peopled with ants and with termites, about half an inch long, of an amber-colour; they cover the brushes and pieces of wood with numberless pipes in clay, and totally destroy them. The buildings of the Transcaspian railway have much to suffer from the attacks of the termites.

WE have received from Mr. Fisher Unwin several of his useful "Half-Holiday Handbooks." They are all for the districts around, and easily accessible from London. They are really handy, in paper covers, easily carried in the pocket, and well printed. Considering their low price, they contain a great deal of varied information and many useful and well-executed illustrations. Besides the objects which attract the ordinary tourist, they give a fair amount of information concerning the natural history of the districts to which they refer, and illustrations of the principal flowering plants, and occasional geological curiosities. We have no doubt these "Handbooks" will meet with a wide sale; and we trust they will be the means of encouraging hard-worked Londoners to explore the beauties and natural productions of the interesting district around the metropolis. The districts so far included in the series are Richmond, Bromley and Keston, Kingston-on-Thames, Tunbridge Wells, Greenwich and Blackheath, Reigate, Croydon to the North Downs, Dorking. With the exception of Kingston, they have all maps and bicycle routes. As a general accompaniment to these, there is one volume devoted to geological rambles and tours, with twenty-five illustrations and sketch-maps.

"DIE Afrika-Literatur in der Zeit von 1500 bis 1750 N.Ch." is the title of a small volume by Prof. Philipp Paulitschke, published by Brockhausen and Bräuer of Vienna. It consists of the titles, with other bibliographical information, of 1212 works and papers and maps on Africa, published during the period embraced. These are arranged under five headings—General, North, West, South, and East Africa. Prefixed is a short, scholarly, and useful introduction on the growth of our knowledge of Africa from 1500 to the time of the great map reformer, D'Anville. The great utility of such a work must be obvious to all, and geographers owe a debt of gratitude to Dr. Paulitschke for the great trouble he has been at in compiling the list, involving, as it must have done, extensive research and correspondence. No doubt omissions will be found that can be supplied in subsequent editions, but the work could scarcely have been better done. We should be glad to know on what authority Dr. Paulitschke states that Lobo's "History de Ethiopia" was *published* at Coimbra in 1859. In the great Portuguese Bibliography there is no mention of its publication, except as embodied in Tellez's "Historia Geral" of 1660. The translation into French by Legrand was made from MS. Under North Africa is given Sir Peter Wyche's "Short Relation of the River Nile," which should have been under East Africa, as it is really only a translation of part of Lobo's narrative published by the Royal Society in 1669. But these are comparatively small matters.

DR. FRIEDRICH EMBACHER's "Lexikon der Reisen und Entdeckungen" is a little work that will be welcome to all interested in the history of geographical discovery; it is published at Leipsic at the "Verlag des Bibliographischen Instituts." It seems to be one of a long series of reference-books ("Meyer's Fach. Lexika") relating to different subjects. Dr. Embacher's volume is neat and well printed; contains brief notices of the leading geographical explorers, from the earliest times down to the present day, including even those now living; for example, there is a long notice of Stanley, and another of Prjevalsky. The first part is followed by a sketch of the progress of exploration in each of the great divisions of the world. The work seems to us to be done with great care, and the bibliographical references will prove very useful. The only omission of importance is the name of Mr. Darwin, which, since the work includes the names of Sir J. D. Hooker, the late Mr. Belt, and even the late Dr. Leared, surely ought to have found a place.

FROM Ferdinand Hirt of Breslau, we have received a volume of "Geographische Bildertafeln," edited by Dr. Oppel of Bremen, and Dr. Ludwig of Leipsic, with the co-operation of several specialists. This is only the first part, and is devoted to general geography. It consists of a series of carefully selected and arranged pictures, illustrating everything that ought to come under the general subject, which, in the German acceptation, seems to be a very wide one. There are in all, twenty-four sheets, containing a varied selection of illustrations of such subjects as the general surface of the earth and instruments of measurement, the geological periods, geological faults, mountain types, glaciers, volcanoes and hot springs, hills and plains, islands and coasts, oceans and seas, harbours natural and artificial, rivers, navigation, charts and meteorology, woods and forests, ethnography, scenes and means of travel, the chase, and so on. The utility of such a collection of pictures is evident. The selection seems to us to be carefully made, many of the illustrations being from well-known books of travel. As a supplement to any text-book of geography, it would be of great service, and would be sure to be welcome to the pupil.

A NEW THERMOGRAPH[1]

THE instrument under consideration is a thermograph for recording the atmospheric temperature, the fluctuations of which are much less regular and more frequent than one who has not made a study of it would suppose. It records the temperature directly from the column of mercury in the tube of a thermometer by dots or perforations upon a sheet of paper previously ruled with degrees and hours.

Its principal parts are, as shown in Fig. 1 of plate:

1. A thermometer in the form of an ordinary mercury thermometer, but open at the top of the tube, and having a wire entering the bulb and connected to one pole of a battery, the other pole of which is connected to the mechanism of the instrument.
2. An upright cylinder revolving by clockwork, covered with a paper which is divided vertically into twenty-four parts by lines representing the hours, and horizontally by lines representing the degrees.
3. A bar raised and lowered by mechanism driven by clockwork, furnished below with a needle entering the tube of the thermometer, and carrying a pencil—or preferably a point—driven forward by a small electro-magnet when the circuit is closed by the needle entering the mercury, and then making a mark at the proper place upon the paper and indicating the temperature.

The bar carrying the needle rises about half an inch from the point at which the needle leaves the mercury, and then descends until the needle again touches the mercury, whether that in the meantime shall have risen or fallen, when the point makes its mark upon the paper and the bar again commences to rise.

This movement is accomplished by the mechanism shown in the drawing, of which only the wheel E, gearing into the rack upon the needle-bar, is shown in Fig. 1, but which is shown in full and upon an enlarged scale in Fig. 2, which is a top view. The two wheels A and B are moved by clockwork (not shown), and are constantly revolving in opposite directions, as indicated by the arrows. These wheels are not attached to the shaft u on which the wheel E is fixed, but are attached to sleeves which move without affecting that wheel except when they are joined to it by the clutches C or D. They are so geared that when the wheel E is joined to them, its rim moves at the rate of half an inch per minute. Upon the shaft with the wheel F is also a loose sleeve F, which is free when the clutch C is not in action, but which moves with that wheel when that clutch is on.

The levers actuating the two clutches unite and move upon a common pivot, from which point they extend as an arm, which is capable of a lateral movement between two stops, bringing one or the other of the clutches into action.

Opposite to the wheel E, the needle-bar passes through a guide, which is furnished on the back with a small wheel taking the thrust of the gear and reducing friction. For a lower guide, the needle-bar is furnished on each side with a rod parallel to the needle, and of nearly the same length. These rods are at such distance apart that they pass clear of the thermometer tube. They are not shown in the drawing, as they would lie directly in front of and behind the needle and tube.

The teeth of the clutches are partly V-shaped and partly square, or nearly so, as shown in Fig. 3; that is, they have slightly tapered sides but V-shaped points and bases, so that they enter freely, as entirely V-shaped teeth would do, and when in action they have no outward thrust. The V-shaped base strengthens the tooth and admits the point of the opposite tooth.

A very small spring on each side of the sleeve F holds it out of gear while the clutch C is off.

Beneath the clutch arm is a pressure spring, one end of which presses against the end of the arm, and the other against a plate moving upon the same pivot with the arm, which plate also is capable of a lateral movement between its stops.

If this spring-plate is moved in either direction to its stop, carrying with it the base of the spring, the clutch-arm will be moved in the other direction, and the clutch on that side will be brought into action; and if the position of the spring-plate with the base of the spring be reversed, the position of the clutch-arm will be reversed—that clutch will be disengaged, and the other one will be engaged—the wheel E being moved, and the needle-bar raised or lowered accordingly.

To the sleeve F is attached an arm which is connected by a draft-rod to the spring-plate.

When the clutch C is in action—as shown in the drawing—connecting the wheel A with the wheel E and the sleeve F, raising the needle-bar, the arm of the sleeve F draws upon the spring-plate—moving to that side the base of the reversing-spring, which, when its base has passed the line between the pivot and the end of the clutch-arm, presses that arm to the other side, disengaging that clutch, loosing the sleeve F, engaging the other clutch, and reversing the motion of the needle-bar, which now descends.

The length of the arm on the sleeve F is such that when the needle-bar has risen half an inch the spring-plate is moved over, and the clutch-action is reversed.

When, by descending, the needle is brought in contact with the mercury and a circuit is made, the large electro-magnet, thus vitalised, attracts its armature, which is attached to a lever connected with and drawing upon the spring-plate, and moves the base of the reversing spring to that side, changing the position of the clutch-arm, and reversing the action of the clutches and the movement of the needle-bar, while at the same time the recording-point upon the needle bar is, by its electro-magnet, driven into the paper, and the temperature is recorded upon the scale.

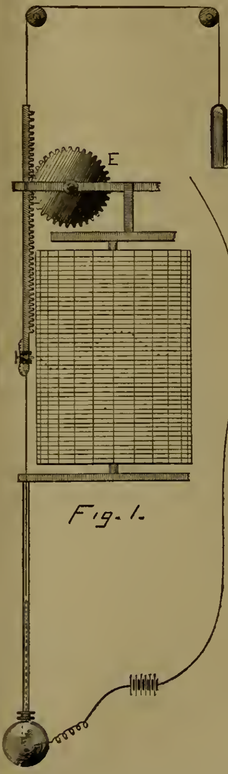


Fig. 1.

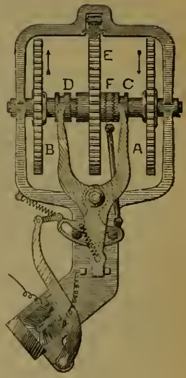


Fig. 2.

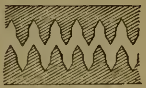


Fig. 3.

The sleeve F, being loose, yields to the movement of the spring-plate, and is afterwards held by its clutch, and acts as before.

The action of the large electro-magnet is supplemented by that of a spring drawing upon the same side of the spring-plate, whose strength is such that it is not quite sufficient of itself to overcome the thrust of the reversing spring, but whose force is greatest when that of the electro-magnet, by reason of

---

[1] A paper by G. Morgan Eldridge, read at the stated meeting of the Franklin Institute April 26, 1882. Contributed by the Author.

its distance from its armature, is least, the greatest possible portion of the work being thus put upon the clockwork, and the least upon the battery.

This spring aids the electro-magnet, but does not in anywise reduce the effect of the reversing spring in holding the clutch to its work ; so long as the base of that spring is unmoved, its action is unimpaired. The resistance of these springs occurs only during the ascent of the needle-bar, which is, therefore, counterpoised to excess, and the resistance and the motion are thus rendered uniform. By reason of the form of the clutch-teeth before described, there is no outward thrust upon the clutches while in action, and hence the reversing spring requires only to be strong enough to throw the arm over and to shift the clutches. The stop of the clutch-arm next the electro-magnet is an insulated plate, to which the battery-wire leading from the magnet is connected, so that as soon as the arm has left the stop the circuit is again broken, although the needle may for a short time remain in contact with the mercury; the recording-point is at once withdrawn, and thus makes upon the paper a single perforation which must be a true record of the position of the mercury in the tube, unaffected by friction or other disturbing cause, since this action must always take place at the moment of contact of the needle with the mercury, and these dots or perforations are repeated at the end of each interval of time required for the needle-bar to ascend and descend the required distance, which will be about two minutes with the wheel-motion designated.

The gradation of the scale upon the paper must correspond with the movement of the mercury in the tube of the thermometer as accurately as the graduation of the scale of an ordinary thermometer corresponds with the movement of the mercury in its tube.

If but one instrument of this sort is to be made this is very easy, the rate of motion is a certained, a scale is made to fit it, and the paper is ruled to that scale.

In all thermometers heretofore made the scale has been made to fit the tube, but if more than one of these instruments is to be made, it becomes necessary, or at least very convenient, to have one set of ruled papers that will fit all the instruments, and it then becomes necessary to reverse the practice and to make the tubes to fit the scale.

The rise and fall of mercury in a thermometer depends upon the proportion between the diameter of the tube and the volume of mercury in the tube and bulb, and while it is possible to construct these parts in such proportion as to obtain proximately a given motion, it is not possible thus to obtain it exactly.

The tube and bulb are made in separate parts, as shown in Fig. 1, of such size that when the tube is thrust half way into the bulb, the volume of mercury filling the tube half way at 32° Fahrenheit is as nearly as may be properly proportioned to the diameter of the tube. If now there be found too much motion, the capacity of the bulb is diminished by thrusting the tube further in, and *vice versa*, and the proper height of mercury at 32° for that purpose is marked upon the tube.

Mercury exposed to the air will slowly form a coating of oxide upon its surface. To prevent this, a small quantity of glycerin or of oil free from oxygen is placed in the thermometer tube above the mercury. If, notwithstanding, the oxide shall accumulate to an inconvenient extent, the observer in charge of the instrument will remove the thermometer from its place, and will put the bulb in warm water until the oxide is floated off. He will then supply the loss with pure mercury, determining the proper quantity by immersing the bulb in broken ice, when the mercury column should stand at the mark for 32°.

The whole apparatus, except the thermometer itself, can be inclosed, and so protected from the weather and dust, while the thermometer is exposed to the air below.

The system is equally applicable to a barometric record, in which case, on account of the small range of motion, the needle-bar is connected to a lever, thus increasing the range of the record.

SCIENCE IN BOHEMIA[1]

THE Bohemian Society of Science continues its useful career, which has already lasted for eighty-four years, and its latest publications (the *Memoirs*, the *Proceedings*, and the annual *Reports*) contain many valuable papers, devoted partly to science in general, but mostly to the exploration of Bohemia itself in its various aspects. The last volume of its *Memoirs* ("Abhandlungen" for 1879–1880, series vi. vol. x.) contains a series of very interesting papers, each of them being the result of careful and extensive research. Prof. Franz Farsky gives the results of varied experiments which were undertaken at the experimental agricultural station at Tabor, on the growth of food-plants in water containing solutions of those salts which constitute the ash of the plant. The influence of alkaline and acid solutions, and especially that of chlorine, which proved to be a most important element of vegetation, were submitted to varied experiments, all the results of which are published in full. The general reader will notice with interest the beautiful results obtained by the culture of oats and barley in glasses of water, which contained the necessary salts, the plant being simply planted in a bit of cotton. Dr. F. J. Studnicka publishes in the same volume the complete tables of observations on the amount of rain in Bohemia during the years 1879 and 1880, at no less than 312 stations in 1879 and at 289 stations in 1880. If we remember that besides these stations there are very many others established by the Bohemian Foresters' Society, and that the whole number of stations where the amount of rain is accurately measured day by day, amounts to 800, we can see that Bohemia has probably the widest network of ombrological observations in Europe. We notice that the most rainy places in Bohemia are Maader, Rehberg, and Neuwelt (1744, 1572, and 1505 millimetres per year respectively), all these situated at great heights (985, 848, and 683 metres), whilst the less rainy places are Kapic, Slaten, and Kladno (431, 438, and 456 millimetres), situated respectively at altitudes of 322, 246, and 380 metres.

Dr. F. Ullik contributes a paper on the matter suspended and dissolved in the water of the Elbe, at Tetschen. Samples of water were taken three times every day, and the samples of each day were analysed separately with regard to the matter suspended, as well as to the quantity of chlorine, ammonia, nitric acid, and organic substances. Besides, 22 complete analyses of different types of water, and 12 of ooze, were made. The water passing through the Elbe at Tetschen proved to be 9,903,510,660 cubic metres during the year October 15, 1876, to October 15, 1877), which contained 776,309,959 kilograms of suspended or dissolved matter. During the year 1877, the amount of water run was 9,456,939,810 cubic metres, which contained 36,557 metrical tons of K^2O, 69,631 tons of Na^2O, 266,081 tons of CaO, 48,915 tons of MgO, 120,553 tons of SO^3, 83,336 tons of chlorine, 778 tons of ammonia, and 11,196 of nitric acid. As to the sources of these immense quantities of mineral substances, Dr. Ullik points out that the amount which is supplied by waste water of manufactures and sewage is usually over-rated. Thus, if the well-known sulphuric acid manufacture at Aussig would pour all the acid it produces into the Elbe, it would give only 5000 tons of SO^3 per year, that is, only the 24th part of sulphuric acid anhydride contained in the waters of the river. The amount of mineral substance poured into the river by all the breweries of Bohemia would give only 401 tons per year, that is, the 1562nd part of all the minerals contained in the Elbe water. And, if all mineral substance contained in the sewage from the 5,000,000 inhabitants of Bohemia would reach the Elbe, it would yield only 33,250 tons, that is, 1-20th of what is really contained in the water of the river. Therefore, it is obvious that the chief source of these substances in the river-water must be sought for in the supply brought in by springs.—Dr. Siegmund Günther contributes to the same volume an interesting notice on the "Algorithmus Linealis," by Heinrich Strömer, which appeared in 1512, being one of the products of the revival of taste for mathematics which characterises, in Germany, the beginning of the sixteenth century. The same volume contains an elaborate paper on the Christian Calendar and on the methods of improving it, by Dr. W. Matzka; and a notice on the electrical clock of Rebicek, by Dr. A. Waltenhofen. It is worthy of notice that all papers that appear in the *Abhandlungen* are written in German, and are sold by the Society as separate pamphlets.

The *Sitzungsberichte*, or Proceedings, contain such a mass of valuable papers that we can notice only the more important of them. They are especially rich in mathematics, and we find (in the volume for the year 1879) papers by Dr. S. Günther, on the application of orthogonal co-ordinates to one problem of the potential theory; on the normals to parabolæ, by Dr. K.

---

[1] "Abhandlungen der Mathematish-Wissenschaftlichen Classe der K. Böhmischen Gesellschaft der Wissenschaften, vom Jahre 1879-1880, vi Folge, Band x. (Prag. 1881). "Sitzungsberichte" of the same Society, for 1879 and for 1880. "Jahresberichte" of the same, for 1879 and 1880.

Zahradnik; a very interesting paper by Prof. Carl Pelz, on the construction of radii of curvature of conic sections, all considered as mere corollaries of one theorem of Steiner; and several papers, by Dr. Franz Studnicka, concerning the theory of determinants and polynomes; and by Prof. J. Solin, on graphical integration.; Prof. A. Safarik contributes a paper giving the results of his observations on the Transit of Mercury on May 6, 1878. After having compared the photographs of the sun during the years 1875 to 1878, with observations on storms at Greenwich, Prague, and Vienna, Prof. Zenger arrived, as is known, at the conclusion that the 12·6 days' periodicity of "storms" on the surface of the sun had the effect of producing the same periodicity in the appearance of tornadoes in the West Indian and of typhoons in the Indo-Chinese Seas. Now, he discusses the storms noticed at Windsor (Australia) during the years 1863-75, and discovers in their appearance the same periodicity; the average deviations from it for the 29 duodecades of each year, being mostly but fractions of one day. But it must be observed that, for calculating the average error of these deviations, Prof. Zenger not only does not make use of the methods of least squares, but takes into account the *signs*, positive or negative, of the deviations, which method considerably diminishes the errors. Discussing Quetelet's tables of falls of meteorites, he arrives at the conclusion that these last also show the same periodicity. An elaborate paper, by Prof. Augustin, gives the results of thirty-eight year's observations of temperature at Prag, the averages being: winter, –0°·56 Cels.; spring, 8°·77; summer, 19°·01; autumn, 9°·60; year, 9°·18.

Several communications are devoted to mineralogy, and we notice among them the papers of Prof. Krejci on the crystallisation of quartz, and on the homœmorphism of Sphalerite, Wurtzite, and Greenokit; on transformation-symbols, by Dr. N. Daubrawa; and on minerals from the Kuchelbad diabase, by MM. Preis and Urba. The papers on palæontology, geology, zoology, and botany, mostly deal with the fauna and flora, fossil or existing, of Bohemia itself. Dr. Ant. Fric gives a list of all fossil animals found in the coal and limestone of the Permian formation in Bohemia; whilst only two species were known from this formation in 1868, M. Fric's list includes no less than 87 species, mostly labyrinthodonts and fishes. Dr. O. Novak publishes his researches on hypostoms of trilobites; and Dr. O. Freismantel contributes three papers: on Nöggerathias of the Bohemian coal-fields; notices on the *Nöggerathia*, Stbg., *Nöggerathiopsis*, Fstm., and *Rhiptozanistes*, Schmalh., and the description of a new Calamaria, *Discinites bohemicus*. M. K. Taranek gives a description of Diatomaceæ from Bohemian marshes; Dr. J. Schöbl publishes the results of his researches on the reproduction of Isopod crustaceans; and Dr. Ullik, the results of several analyses of Bohemian waters. In the Ethnographical Department we notice a paper by Dr. Jirecek, on Walachians and Mauro-Walachians, according to documents found at Ragusa.

The next volume of the *Sitzungsberichte*, for the year 1880, is as rich as the preceding one. Dr. F. Studnicka continues his researches on the theory of determinants, and describes a new property of them, already observed by M. Catalan; and M. F. Mertens gives a new geometrical application of the rule of multiplication of determinants. Dr. A. Seydler studies the movement of a point on given curves and superficies. In the domain of physics we notice but one paper, by Dr. K. Domalip, on the alternating discharges of electricity in rarefied space, in which paper the author deals especially with luminous back-currents. The researcees of Prof. W. Zenger on the 12·6 days' periodicity, are continued in this volume. He remarks that this period is equal to one-half of the duration of each rotation of the sun, and tries to prove that the earthquakes in Southern Italy, from 1349 to 1873, as given by Prof. Suess, also fell on such days as closely coincide with the 12·6 days' period. He discovers the influence of the same periodicity in the dates of the passage of comets, from A.D. 371 to 1864, through their perihelium, as well as in the dates of meteoric showers. In further papers he tries to establish that the same periodicity might be discovered as to the maxima and minima of atmospheric pressure, of temperature, &c., and of magnetic disturbances. Finally, he shows that the sidereal durations of the revolutions of all planets are but multiples of the half rotation of the sun, and he finds that the same number appears also in the lengths of the months of the moon and of the satellites of Jupiter, Saturn, and Uranus. He concludes that "the cause of the movements in our solar system must be sought for in the rotation of the sun," and that all phenomena of gravitation, magnetism, and electricity are but modifications of the same cause which occasions the rotation of the sun. Dr. F. Augustin contributes a paper on the climate of Prag, being a *résumé* of the meteorological observations made since 1840, and another paper on the influence of clouds on the diurnal march of temperature at Prag. Among geological papers we notice: the communication by Dr. Fric on the discovery of fossil remains of a bird, *Cretornis Hlavaci*, in the chalk of Bohemia ("Iserschichten"); the description of a new Tertiary Batrachian, *Palæobatrachus bohemicus* (H. v. Meyer), from the brown coal at Böhmisch-Kamnitz, very similar to the *Palæobatrachus Goldfussi*, but different from it in the structure of several parts of the skeleton. M. Carl Heistmantel contributes two papers on the fossil flora of the Hangend-ridge of the Kladno-Rakonitz coal-basin, characterised by the abundance of *Filices*, *Alethopteris Serli*, and *Cyatheites arborescens*, being most common, and appearing in masses, whilst the *Sphenopteris* is scarcely represented, the *Neuropteris*, so characteristic of the lower deposits, completely disappears, and the Lepidodendrons become very rare. The group of *Leiodermaria* becomes, on the contrary, most usual, and acquires a new representative in the Permian *Sigillaria denudata*, Göpp., whilst Conifers become more numerous. The flora acquires thus a decidedly Permian character. Mr. J. Woldrich contributes a paper on the diluvial fauna at Sudslavic, close by Vimperk; it bears a decidedly northern character, as it contained remains of *Myodes torquatus*, *Nyctea nivea*, *Leucocyon lagopus*, *Fœtorius Erminea*, *Lepus variabilis*, *Arvicola nivalis*, *A. gregalis*, *Lagopus alpinus*, &c. Prof. A. Belohoubek gives an interesting sketch of the influence of geological structure on the chemical composition of water in very many springs and wells from different geological formations: old gneisses, Huron, Silurian, Carboniferous, Permian, Chalk, Tertiary, and Diluvium in Bohemia. The best water, as far as can be concluded from M. Belohoubek's researches, which he considers himself as only preliminary—is given by the Gneiss, Permian, and partly also by the Chalk; the worst, by the Carboniferous and Silurian. Dr. Vejdovsky gives a list of Rhizopods inhabiting the wells at Prag, several species of *Amœba*, *Centropyrix*, *Euglypha*, *Trinema*, &c., being characteristic for special wells. M. Taranek gives a description of Diatomaceæ at Warnsdorf. Prof. J. Dedecek gives a sketch of Bohemian Polytrichaceæ, and deals in another paper with the distribution of Hepatic mosses in Bohemia.

In the *Annual Reports* we notice, besides the public lectures read at the annual meetings, a most useful, complete bibliographical indexes of works and papers published by different members of the Society since the beginning of their scientific careers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—From the annual report on the local lectures in populous centres, we learn that 12 out of 23 courses of lectures in the Michaelmas Term of 1881, and 10 out of 20 courses in the Lent term of 1882, were on scientific subjects, and were delivered to audiences amounting in all to 1042 persons in the former term and 645 in the latter. This refers only to the work exclusively conducted from Cambridge, without including the courses of lectures in London and in the counties of Durham and Northumberland, which are also largely under the influence of the Cambridge system.

University College, Nottingham, has applied to be affiliated to Cambridge.

A further report of no progress has been made by the Sedgwick Museum Syndicate. It is estimated that 14,716*l*. is the present value of the investments and balances of the Memorial Fund. All that can be said as to the prospects of building is that further acquisitions of sites near the new museums make satisfactory proposals more possible. Prof. Hughes has addressed a letter to the Vice-Chancellor showing that a considerable proportion of the funds for building the present Woodwardian Museum and Library was sought and given expressly for a geological museum, so that the University may fairly be expected to find 15,000*l*. as the value of the present museum if it takes possession of it for the use of the Library.

The first part of the Natural Sciences Tripos has placed 24 men in the first class, 20 in the second, and 10 in the third, while

7 receive an ordinary degree, and 5 are excused the general examination. Six lady students are formally classed, the three in the first class being Girton students. Thus we have the unprecedented total of 72 names in one tripos list in natural science at Cambridge. Of those in the first class, Trinity and Christ's Colleges furnish 6 each, St. John's 5, Caius and King's 2 each, and Emmanuel and Clare and the non-collegiate students one each.

UNIVERSITY COLLEGE, LONDON.—Mr. L. F. Vernon-Harcourt, M.Inst.C.E., has been appointed Professor of Civil Engineering and Surveying. Mr. Kennedy retains the Professorship of Engineering and Mechanical Technology.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 5.—On the relations between galvanic polarisation and the surface-tension of mercury, by A. Koenig.—On the work of external forces furnished in a closed circuit, by R. Colley.—On galvanic polarisation, and on the Smee element, by W. Hallock.—Theory of circulatory and elliptically-polarising media, by E. Ketteler.—On the change of the colour-tone of spectral colours and pigments with decreasing intensity of light, by E. Albert.—On the influence of deformation on electric conductivity, by A. Witkowski.—Researches on the height of the atmosphere and the constitution of gaseous heavenly bodies, by A. Ritter.

Journal de Physique, May.—Electro-chemical figuration of equipotential lines on any portions of a plane, by A. Guébhard—Note on the tangent-compass, by M. Mascart.—Variation of the coefficient of viscosity with the velocity, by B. Elie.—Apparatus for showing and measuring in projection, and simultaneously, the plane of polarisation of the analyser and of the crystalline plate, by L. Laurent.—Register of the duration of rain, by M. Schmeltz.

Bulletin de l'Académie des Sciences de St. Pétersbourg (vol. xxviii. fasc. 1).—Analysis of samples of water from lakes and sources in Tibet, by Dr. C. Schmidt.—Measurements of crystals of Datolith, Amphibol, and Vanguelinit, by B. Koksharow.—On the necessary degree of sensibility of magnetic variation instruments, by H. Wild.—Galvanic phenomena in the cerebrospinal axis of the frog, by J. Setschenow.—Remarks on the Amphisbænids, by Dr. A. Strauch.—New researches on the hypothesis of a resisting medium, by O. Backlund.—Effects of the tension on the electrical resistance of copper-wires, by O. Chwolson.

WE notice in the last number of the "Journal of the Russian Chemical Society" (vol. xiv. fasc. 4), an interesting paper by M. Radoulowitch, on the formation of peroxide of hydrogen during the oxidation of the terpenes, in which he tries to establish, contrary to the opinions of MM. Berthelot and Papasogli, that the oxidation processes manifested by the turpentine oil are not due to the presence of oxygenated compounds of nitrogen, but to the presence of peroxide of hydrogen. In the same number of the "Journal" Prof. Menshutkin gives a summary of his extensive work on the formation of ethers. M. Schwedoff contributes a paper in which he refutes the opinions as to the tails of comets being the result of the repulsive force of the sun on the matter of the comets, and especially the conclusions arrived at by Prof. Bredikhin on the subject; and M. Jouk publishes numerical results as to the temperatures of boiling of methyl alcohol and amylene.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, June 8.—S. Roberts, F.R.S., president, in the chair.—Messrs. J. W. Berry, A. R. Forsyth, and J. Wood were elected Members, and Mr. R. A. Roberts was admitted into the Society.—The following communications were made:—On the extension of certain theories relating to plane cubics to curves of any deficiency, A. Buchheim [the object of the paper was the extension, by the use of Abelian functions, of certain theories which, in the case of plane cubics, are immediate consequences of the representation of the co-ordinates of a point of the curve as elliptic functions of a parameter. The theories considered were: (1) the theory of Steiner's polygons, and (2) Prof. Sylvester's theory of derived points (cf. Clifford's "Classification of Loci")].—On the differentiation with respect to the modulus of the amplitude of elliptic functions, Rev. M. M. U. Wilkinson.—Two notes: (1) a definite integral; (2) equation of the director circle of a conic, Prof. Wolstenholme [(2) got, in the case of oblique cartesian co-ordinates, in the form $\frac{d^2u^{\frac{1}{2}}}{dx^2} + \frac{d^2u^{\frac{1}{2}}}{dy^2} = 2\frac{d^2u^{\frac{1}{2}}}{du\,dy}\cos\omega$].—Theory of orthoptic loci, Rev. Dr. Taylor [the *orthoptic locus* of any curve is the locus of intersection of tangents at right angles].

Linnean Society, June 1.—Frank Crisp, LL.B., treasurer, in the chair.—Mr. H. C. Burdett was elected a Fellow of the Society.—Mr. H. N. Ridley drew attention to an *Equisetum maximum* from Swanage, having a spike of fructification surmounted by a branch-bearing portion, and remarkable on account of the transition of the sporophores along with the brown acuminate leaves..—The Rev. G. Henslow exhibited malformed specimens of wallflower, of rhododendron, and of the Garden Ranunculus.—Mr. Marshall Ward read a paper on his researches on the life history of *Hemileia vastatrix*, the fungus of the coffee-leaf disease. The phenomena attendant thereon shows great analogy to those of the Uredine fungi. The spores, under favourable conditions, viz., moisture, a due supply of oxygen, and a temperature of 75° F., usually germinate in from twelve to twenty-four hours.—Complete infection or establishment of the mycelium in the intercellular passages of the leaf occurs about the third day after the formation of the germinal tubes. The so-called yellow spot or ordinary outward visible appearance of the disease manifests itself about the fourteenth or fifteenth day, but may be delayed; its development and course being dependent on secondary causes, such as atmospheric conditions, monsoons, age of the coffee-leaf, &c. By watching the progress of the spots it has been ascertained that the spores therefrom may be continuously produced for from seven to eleven weeks or even more. Some 150,000 spores have been estimated as present in one yellow cluster spot, and as 127 disease spots have been counted in one pair of leaves, the quantity of spores thus regularly produced must be enormous. According to the amount of diseased spots, the sooner the leaf falls; and though young leaves arise, the fruit-bearing qualities of the plant necessarily are seriously interfered with. The various sorts of coffee plant are all liable to infection; the only possible remedy is the difficult one of destruction of the spores, and these are supposed originally to have been introduced from the native jungle, and rapidly spread under the favourable conditions of artificial cultivation.—Dr. Hoggan read a paper on some cutaneous nerve-terminations in mammals. He related observations on the habits of the mole (*Talpa*), with reference to its nasal organ, as a special sense of touch, and of the tail as a tactile organ. The so-called "Organ of Eimer" in the mole's nose, its fibres and cells, are similar in character to the ordinary sub-epidermic nerve-cells and their intrapidermic fibrillar prolongations. There is a probability that the inner circle of fibrils possesses the power of touch, and that the centre ones and those of the outer circle provide the sense of temperature, pain, and other sympathetic functions. The Paccinian bodies at the root of the organ probably register pressure.—Mr. C. B. Clarke read a paper on two Himalayan ferns erroneously described in the ferns of British India.—A communication was made on the Ascidians collected in the cruise of the yacht *Glimpse* in 1881, by Mr. H. C. Sorby and Prof. W. A. Herdman. Twelve species were noted, one *Molgula cæpiformis*, from near Poole, being new.—Mr. P. H. Carpenter followed by descriptions of new or little-known Comatulæ, being material derived from the *Challenger* expedition and Hamburg Museum. The author institutes the new genus *Eudiocrinus* for Semper's *Ophiocrinus*.—Two other papers read were:—Notes on recent additions to the New Zealand flora, by Mr. Thos. Kirk, and descriptions of four new species of *Donax*, by Mr. Sylvanus Hanley.

Physical Society, June 10.—Prof. Clifton, president, in the chair.—New member, Major-General Martin, R.E.—Mr. W. F. Stanley read a paper on sonorous vibrations, especially those of the tuning-fork. The larger and more visible movements of a sounding-body do not appear to be best fitted to propagate musical-sounds as was shown by placing disks on the prongs of a powerful fork, which, when vibrating, could then only be heard a short distance, whereas, by its smaller longitudinal motions, when placed on its resonator, it produced a penetrating sound. The vibration down the stem of the fork was shown not to depend upon a vibrating ventroid, as suggested by Chladni, for a fork cut in the end of a solid steel bar communicated sonorous vibrations equally well to the resonator. To set a fork in vibration it was necessary to bow one prong only, therefore, in this case, the vibration must proceed along the prongs. A light fork 1 metre long was fixed in a heavy vice, and it was shown by it that vibrations passed down one prong and up the other alternately. By means of dust, ripples were shown to run down an ordinary fork in vibration. Light pieces of metal were fitted to the ends of a powerful fork, and these immersed in mercury, the reflected surface of which was shown on a screen, where it was seen that the whole mercury surface was broken into fine ripples. It was suggested that such small waves are also perceived by the ear. By these, certain conditions of harmonics could be better accounted for, as, for example, by division in smaller waves, the rarefaction of a note in space would not suffer interference by the condensation of its octave falling in the same space and time.—Lord Rayleigh explained several of Mr. Stanley's experiments on the known theory of sound.—Mr. Walter Bailey then exhibited a model of a new "integrating anemometer." This apparatus contains a horizontal plane, in which are two slits forming a cross with arms towards the cardinal points. Each slit is fitted with a sliding-piece, and the two slides are connected by a bar; the arrangement being that of the well-known instrument for drawing ellipses. The slides carry beneath them wheels with their planes perpendicular to the slits, and passing through the pivots of the bar. The wheels rest on a horizontal disk, whose centre is beneath the centre of the cross. The centre of the bar is to be connected to a weathercock which will keep it in the direction of the wind when looked at from the centre of the instrument. The disk is to be revolved by Robinson's cups. The number of revolutions of the wheels then give the integral of the resolved parts of the wind in the direction of the cardinal points. In the working model of the instrument exhibited there was an electrical arrangement connected with four indicators, one for each of the cardinal points. At each turn of a wheel a circuit was completed, and the corresponding indicator moved. Recording instruments are to be substituted for indicators, and the amount recorded on each in a given time will be proportional to the total motion of the wind towards the corresponding cardinal point.—Mr. Lecky pointed out that a good anemometer was a great desideratum at present.—The Society meets at Oxford on the 17th, and South Kensington on the 24th of this month.

Anthropological Institute, May 23.—General Pitt-Rivers, F.R.S., president, in the chair.—A paper was read by the Right Hon. Sir H. Bartle Frere, Bart., on systems of land tenure among aboriginal tribes of South Africa." The author indicated the points regarding which further inquiry is needed, and urged the importance of recording observations whilst it is still possible to obtain information from sources which in the course of another generation may be closed for ever by the extinction of races. The Zulu title to the lands in South Africa rests simply on force, the land being his property only so long as the occupant can hold it by himself, or with the assistance of the chief who protects him. The tenure cannot be transmitted by inheritance without being constantly sapped by the influence of two institutions universal among the Zulus, viz., polygamy and slavery. Christianity has a special bearing on the subject of land tenure, because it is mainly through its agency, indirect as well as direct, that we may look for such changes in the customs of the races of South Africa as may civilise and settle them, and put an end to the ceaseless wanderings which have tended so powerfully to keep them in a state of ever-recurring barbarism. The author's impression was that the advancement and civilisation of the native tribes of South Africa depend greatly upon the extent to which individual tenure of property can be extended, whilst some patriarchal authority such as seems inherent in the head of a family or kraal is recognised, and invested with some sort of magisterial and judicial functions, sufficient to meet the everyday exigencies of village life. The President opened the discussion with some remarks on the peculiarities of land tenure in various parts of the world, and was followed by Dr. Rae, Mr. Hyde Clarke, and Miss Buckland.—On the motion of Prof. Flower, a cordial vote of thanks was given to the president and Mrs. Pitt-Rivers for their kindness in allowing the meeting to be held at their house.

Edinburgh

Royal Society, June 5.—The Right Hon. Lord Moncrieff, president, in the chair.—Obituary notices of Dr. Lauder Lindsay, Mr. David Smith, and Prof. Peirce of Harvard, were read.—The Council announced the award of the Keith Prize for the Biennial Period 1879–81, to Prof. Chrystal, for his paper on the differential telephone, which is published in the Society's *Transactions* (1879-80), and gives a new, simple, and accurate method of measuring capacities and co-efficients of mutual and self-induction (see Nature, vol. xxii. p. 331); and of the Neill prize, for the triennial period 1877-80, to Mr. John Murray, for his paper on the structure and origin of coral reefs and islands, communicated to the Society on April 5, 1880, and printed (in abstract) in the *Proceedings* of that date (see Nature, vol. xxii. p. 351).—Prof. Tait communicated Part II. of his paper on mirage. Having formerly shown that the observed phenomena could be explained in a general way by assuming a certain relation to exist between the refractive index of the air at any point, and its situation between two planes of approximately stationary density; the author, in his second paper, proceeded to investigate the conditions more carefully, so as to find, if possible, a distribution of atmospheric density which should be at once probable, and produce mirage phenomena the same in all important particulars as those observed by Scoresby, Vince, and others, and at the same time be capable of easy mathematical treatment. Two horizontal strata of uniform but different densities, separated by a stratum whose density varies continuously from the one to the other, were found to give results in close agreement with observation. That a stratum of air should remain of practically uniform density through even a comparatively small height requires a lowering of temperature to compensate for the diminution of pressure as the height increases; but this rate of change of temperature Prof. Tait showed was not greater than had been observed in balloon ascents. With given thicknesses of strata, there was a critical minimum distance at which mirage could be obtained. For greater distances there were three images, two direct and one inverted. The inverted one was always larger than the lower direct one, but only appreciably so when the distance of the object approached this critical minimum value, for which the phenomenon known as "looming" became evident. The second direct image is usually much the smallest, being, except at distances near this same critical distance, so small as to be practically invisible. This seems fully to account for the comparatively few instances in which the three images have been observed. Multiple inverted images, as observed by Scoresby, were explained as due to thin successive layers of varying density at different heights. It was shown that Wollaston's illustrative experiment, in which three images are produced, is *not* quite analogous to the state of affairs which produce them naturally. In order to make it so, the tank must be greatly increased in length, and the difference of density of the interdiffusing fluids greatly diminished; so that the rays may enter and leave the transition stratum by its lower side, and *not by its ends*. The rest of the paper showed how Wollaston's arrangement could be simply and accurately applied to measurement of rates of diffusion.—Mr. Milne Home communicated the Eighth Report of the Boulder Committee. This dealt mainly with the boulders around Ben Nevis, which had been examined by Prof. Heddle, Prof. Duns, and Mr. Livingston of Fort William.

Berlin

Physical Society, May 26.—Prof. du Bois-Reymond in the chair.—Prof. Landolt showed a new polarisation-apparatus, whose polarising part is formed according to the method of M. Cornu, modified by Herr Lippich, and which has this advantage over others, especially, that it is not mounted on a foot, but on a solid base, whereby bending and torsion of the tube which holds the liquid are avoided. This tube is inclosed in a cylindrical envelope, in which water of any desired temperature can circulate. By a simple lever movement, the tube filled with the experimental liquid can at any time be directly replaced by an empty tube, and conversely; so that the zero point can be controlled as often as desired. In its present form, the apparatus is pretty perfect for scientific researches; further improvement must be directed principally to the production of a good light-source. Some proposed alterations of the apparatus, now in hand, will afford the opportunity of examining vapours in reference to their rotatory power.—Dr. Hagen reported on experiments for measuring the vapour-tension of mercury at different temperatures. He first indicated briefly the apparatus Regnault used, and the results obtained with it, by that physicist. The values given by Regnault are met with in all text-books of physics; yet they differ very considerably from the amounts found by Regnault in his experiments, and these do not agree together. The author, therefore, undertook a new determination of these values. The apparatus consisted of a U-shaped tube, having at the lower part a long straight tube, united to it by fusion, while above, either branch terminated in a tube twice bent at a right angle, and closed at the lower end. By means of a Hagen air-pump this tube-system was gradually evacuated to a pressure of 1-12,000,000 mm. mercury, and the long straight tube opened under mercury at the lower end. The mercury rose in both branches of the U-tube to barometric height. One of the lateral ends of the apparatus was now kept constant at 0°; while the other was first cooled to – 42°, and then heated to various temperatures; each time the position of the mercury in the two branches was observed with a cathetometer, and the difference of their heights gave the vapour-tension. The values so obtained for the vapour-tension of mercury were less for all temperatures than those given by Regnault. Thus, *e.g.* Herr Hagen found the tension at 0° = 0·015 mm., Regnault 0·02; at 20°, Hagen 0·021, Regnault 0·037; at 100°, Hagen 0·61, Regnault 0·75; at 200°, Hagen 16, Regnault 19·9 mm. Though the values now found have no claim to absolute accuracy (owing to the difficulty of taking readings with the cathetometer, through round glass), these experiments at least make certain that the Regnault values for the vapour-tension of mercury, which have passed into all text-books, are considerably too large.

PARIS

Academy of Sciences, June 5.—M. Jamin in the chair.—The following papers were read:—On double salts prepared by fusion, by MM. Berthelot and Ilosvay.—Report on the expedition to Cape Horn, by H. Milne-Edwards. This meteorological mission, to start soon, for a year's sojourn at Cape Horn, will have two medical men, Drs. Hyades and Han, who have undertaken to collect and make observations as the Academy may indicate. A Committee of the Academy has urged the Government to add a preparer of collections, and nominated M. Sauvinet for this post; total additional cost 3625 fr. The wish is expressed that specialists in zoology, botany, and geology could have been appointed; but the resources did not allow of this.—Zoological instructions drawn up for the members of the Cape Horn Mission by M. Alph. Milne-Edwards. Special attention should be given to the large mammalia—seals, sea-elephants, otaries, cachalots, &c., some of which are rapidly disappearing. Various penguins and other sea-birds call for study; the fishes are imperfectly known, and a good harvest from dredging operations may be looked for.—The true puceron of the vine (*Aphis vitis*, Scopoli), by M. Lichtenstein.—History of standards of the metre, by M. Wolf.—On the waves produced by the emersion of a solid at the surface of a quiet wave, when there is occasion to take account of two horizontal co-ordinates, by M. Boussinesq.—On the boiling-temperature of selenium, by M. Troost. Employing a method described March 29, 1880, he arrives at the figure 665° C. for pressure near 760 mm. It is shown that glasses of small fusibility, such as Bohemian and certain French glasses, may be kept at that temperature without deformation, and so used for long chemical reactions.—On a calorimeter dependent on cooling, by M. Violle. This is for use where the initial temperature is between 100° and 400° or 500°. It consists of a small, narrow-necked bottle of thin glass, with double envelope, and a vacuum produced in the interval before closure. Through the neck is introduced a thermometer and a stirrer.—Determination of the specific heats of small quantities of substances, by MM. Thoulet and Lagarde. The method is designed for pure mineral species (0·1 gr. to 0·5 gr.). Its principle is this: If two thermo-electric junctions be put in tubes holding a liquid of known specific heat (*e.g.* water, or oil of turpentine), one may measure, by the deflection in a galvanometer, the rise of temperature resulting from immersion in one of the tubes of a body raised to a known temperature, and compare it with that in a second experiment made with a typical body (*e.g.* copper). The method (which is illustrated by a figure) is shown to be exact.—On a new condensation-hygrometer, by M. Crova. A small tube of nickel-plated brass, carefully polished within, is closed at one end with ground glass, and at the other with a lens of long focus, through which one looks along the tube towards a light-source. Through two terminal tubulures, the air to be examined is drawn through the tube, which is cooled by means of sulphide of carbon traversed by an air current in a metallic envelope round the tube. The changes of aspect in the tube at the temperature of saturation, enable one to estimate the dew-point to one-tenth of a degree.—Law of freezing of aqueous solutions of organic matters, by M. Raoult. The molecules of different organic matters, dissolved in the same quantity of water, cause sensibly the same retardation in its freezing-point.—Method for determination of the ohm, by M. Joubert.—Influence of the positive electrode of the battery on its chemical work, by M. Tommasi.—On oxychlorides of zinc, by M. André.—Action of sulphide of carbon on silicium, by M. Colson.—Preliminary note on didymium, by M. Clève. This points to the existence of a new element accompanying didymium. The author proposes to designate it provisionally by the symbol Di β; it is characterised by the strong line *l* = 4335·5.—On a new monochlorinated camphor, by M. Cazeneuve.—On spontaneous fermentations of animal matters, by M. Béchamp. He reviews past researches, and indicates a number of deductions from them.—MM. Cazeneuve and Daremburg called attention to the fact of proof having been given by them in 1874, that in general all the substances called *colloid* by Virchow and his school, strongly decompose oxygenated water.—On the nerve-tissue of the spinal cord, by M. Ranvier.—Experimental attempt at anatomical localisation of symptoms of toxical delirium in the dog, by M. Danillo.—Essence of absinthe was injected into dogs. The integrity of the optic thalami is not necessary for production of toxical delirium. The cortical region throughout is exclusively concerned.—M. Larroque furnished some data regarding the thunderstorm of May 30. In some regions there was torrential rain, in others hail.—On a new combination of the lenses of the microscope, by M. Zenger. With a great focal distance he obtains a magnification equal to 2000.

VIENNA

Imperial Academy of Sciences, May 11.—L. I. Fitzinger in the chair.—H. Hammerl, contributions to the knowledge of the formation of hydrates of salts.—P. Wesselsky and R. Benedikt, on some nitro-products from the pyrocatechin series.—F. Exner, determination of the ratio-electrostatic and electro-magnetic absolute unit.—A. Tschinkel, communication on experiments relating to the action of electricity on the growth of plants.—F. Heger, continuation of the fifth report of the Prehistoric Commission on two excavations near Chotzen (Boh.) and near Hallein (Salzburg).—G. Bruder, contributions to a knowledge of the Jurassic deposits in Northern Bohemia.—E. Stefan, on the lines of force of a field symmetrical round an axis.

May 25.—Anniversary Meeting.—E. v. Bruecke was elected vice-president in room of V. Burg.—In the Mathematical class, Theodor v. Oppolzer (Vienna), Julius Wiesner, and Emil Weyr Vienna, were elected Members.—Fr. E. Schultze (Gratz), V. v. Ebner (Gratz), M. Neumayr Vienna), L. v. Pebal (Gratz), H. Durège (Prague) Correspondents, Friedrich Woehler (Göttingen) Honorary Member, L. Pasteur (Paris) G. G. Stokes (Cambridge) and T. Lovén (Stockholm) foreign correspondents.—The meeting was opened by the curator of the Academy, Archduke Rainer. The reports for the past year were read by the general secretary, Prof. Siegel and the secretary of the Mathematical Class, Prof. Stefan.—Then Prof. E. Much (Prague) gave an address on the economic nature of physical research.

CONTENTS

THURSDAY, JUNE 22, 1882

CHARLES DARWIN[1]

V.

THE effects upon Psychology of Mr. Darwin's writings have been so immense, that we shall not overstate them by saying that they are fully comparable with those which we have previously considered as having been exerted by the same writings on geology, botany, and zoology. This fact at first sight can scarcely fail to strike us as remarkable, in view of the consideration that Mr. Darwin was not only not himself a psychologist, but had little aptitude for, and perhaps less sympathy with, the technique of psychological method. The whole constitution of his mind was opposed to the subtlety of the distinctions and the mysticism of the conceptions which this technique so frequently involves; and therefore he was accustomed to regard the problems of mind in the same broad and general light that he regarded all the other problems of nature. But if at first sight we are inclined to feel surprised that, although possessing none of the special mental equipments of a psychologist, he should have produced so enormous an influence upon psychology, our surprise must vanish when we consider the matter a little more attentively. For the truth of this matter is that psychology, in being the science furthest removed from the reach of experimental means and inductive method, is the science which has longest remained in the trammels of *a priori* analysis and metaphysical thought; therefore Darwin, by casting the eye of a philosophical naturalist upon the facts, without reference to the cobwebs which the specialists had woven around them, was able to gather directly much new information as to their meaning. And the rare sagacity with which he observed and reflected upon the phenomena of mind merely as phenomena or facts of nature, led to the remarkable results which we shall presently have to consider—results which have done more than any other to unmuffle the young science of psychology from the swaddling clothes of its mediæval nursery.

The portions of Mr. Darwin's writings which refer to mental science are very limited in extent—comprising, in fact, only one chapter in the "Origin of Species," three in the "Descent of Man," and a short paper on the development of infantile intelligence. The importance of the effect produced by them is therefore rendered all the more remarkable; but in this connection it seems desirable to state that the chapters to which we have alluded represent, in an exceedingly condensed form, the result of extensive thought and reading. A year or two ago Mr. Darwin lent the present writer the original drafts of these essays, together with all the notes and memoranda which he had collected on psychological subjects during the previous forty years, and so we can testify that any one who reads these MSS. is more likely to be surprised at the amount of labour which they indicate than at the effect which has been produced by the compressed publication of its results. What strikes one most in reading the MSS. is that which also strikes one most in reading the published *résumé* that has grown out of them—namely, the honest adherence throughout to the strictly scientific, or, as the followers of Comte would say positive method of seeking and interpreting facts; speculation, hypothesis, and straw-splitting are everywhere, not so much intentionally avoided, as alien to the whole conception of the manner in which the sundry problems are to be attacked. We all know that this conception has not met with universal approval—that more than one writer, adhering to the traditional methods of psychological inquiry, has expressly joined issue upon it. But although it is an easy matter for a technical psychologist to point to an absence of technical thought, and so of a recognition of technical principles, in these parts of Mr. Darwin's writings, we are persuaded that the *exposé* only serves to reveal a beam in the eye of the technical psychologist which prevents him from seeing clearly how to remove the mote from Mr. Darwin's. In other words, although it is true that Mr. Darwin does not recognise the niceties of distinction which seem so important to what we may term the professional mind, it is no less true that in the cases to which we have alluded, the professional mind has failed in its duty of filling up for itself the technical *lacunæ* in Mr. Darwin's expositions. Such *lacunæ* no doubt occur, but they never really vitiate the integrity of the conclusions; and a trained psychologist would best fulfil his function as an under-builder, by supplying here and there the stones which the hand of the master has neglected to put in. To ourselves it always seems one of the most wonderful of the many wonderful aspects of Mr. Darwin's varied work, that by the sheer force of some exalted kind of common sense, unassisted by any special acquaintance with psychological methods, he should have been able to strike, as it were, straight down upon some of the most important truths which have ever been brought to light in the region of mental science. These we shall now proceed to consider.

The chapter in the "Origin of Species" to which we have referred, is occupied chiefly with an application of the theory of natural selection to the phenomena of instinct, and in our opinion it has done more than all other psychological writings put together to explain what instinct is, why it is, and how it came to be. Before this chapter was published, the only scientific theory concerning the origin of instincts that had been formed was the theory which regarded them as hereditary habits. Because we know that in the individual intelligent adjustments become, by frequent repetition, automatic, it was inferred that the same might be true of the species, and therefore that all instincts were to be regarded as what Lewes has aptly termed "lapsed intelligence." In this view there is, without any question, much truth, and the first thing we have to notice about Mr. Darwin's writings with reference to instinct is that they not only recognised this truth, but, by elucidating the whole subject of heredity, placed it in a much clearer light than it ever stood before. Mr. Darwin, however, carried the philosophy of the subject very much further when he argued that, in conjunction with the cause formulated as "lapsing intelligence," there was another at least as potent in the formation of instincts—namely, natural selection. His own statement of the case is so terse that we cannot do better than quote it.

"If Mozart, instead of playing the pianoforte at three

---

[1] Concluded from p. 147.

years with wonderfully little practice, had played a tune with no practice at all, he might truly be said to have done so instinctively. But it would be a serious error to suppose that the greater number of instincts have been acquired by habit in one generation, and then transmitted by inheritance to succeeding generations. It can be clearly shown that the most wonderful instincts with which we are acquainted, namely, those of the hive-bee and of many ants, could not possibly have been acquired by habit.[1]

"It will be universally admitted that instincts are as important as corporeal structures for the welfare of each species, under its present conditions of life. Under changed conditions of life, it is at least possible that slight modifications of instinct might be profitable to a species; and if it can be shown that instincts do vary ever so little, then I can see no difficulty in natural selection preserving and continually accumulating variations of instinct to any extent that was profitable. It is thus, I believe, that all the most complex and wonderful instincts have originated."

Briefly, then, in Mr. Darwin's view instincts may arise by lapsing intelligence, by natural selection of accidental and possibly non-intelligent variations of habit, or by both principles combined—seeing that "a little dose of judgment" is often commingled with even the most fixed (or most strongly inherited) instincts. One good test of the truth of the view as a whole is that which Mr. Darwin has himself supplied—namely, searching through the whole range of instincts to see whether any occur which are either injurious to the animals exhibiting them, or beneficial only to other animals. Now there is really no authentic case of the former, and the latter are so few in number that they may reasonably be regarded, either as rudiments of instincts once useful (so analogous to the human tail), or as still useful in some unobservable manner (so analogous to the tail of the rattlesnake). The case of aphides secreting honey-dew for the benefit of ants occurred to Mr. Darwin as one which might be adduced against his theory in this connection, and he therefore made some experiments upon the subject, which led him to conclude that "as the excretion is extremely viscid, it is no doubt a convenience to the aphides to have it removed; therefore probably they do not excrete solely for the good of the ants."

A discussion of the variability of instinct, and of the probability that variations should be inherited, leads him to consider the important case of the apparent formation of artificial instincts in our domestic dogs by continued training with selection, and also the not less important case of the effects produced upon natural instincts by the long-continued change of environment to which other of our domestic animals have been exposed. All the facts adduced as resulting from these long-continued though unintentional experiments by man, go to substantiate, in a very unmistakable manner, the theory concerning the origin and development of instincts which we are considering. The chapter concludes with a close consideration of some of the more remarkable instincts which occur in the animal kingdom, such as the parasitic instinct of the cuckoo, the slave-making instinct of ants, and the cell-making instinct of bees. A flood of light is thrown upon the latter, and the old-standing problem as to how the bees have come to make their cells in the form which requires the smallest amount of material for their construction, while affording the largest capacity for purposes of storage, is solved.

From this brief account of the chapter on "Instinct," it is evident that the new idea which it starts, and in several directions elaborates, is an idea of immense importance to psychology, and that the broad marks or general principles laid down by it afford large scope for a further filling in of numberless details by the attentive observation of facts. The phenomena of instinct, indeed, cease to be rebellious to explanation, and range themselves in orderly array under the flag of science.

But not less important than the chapter on "Instinct" are the chapters in the "Descent of Man" on the mental powers of man as compared with those of the lower animals, on the moral sense, and on the development of both during primæval and civilised times. Our estimate of the value of these chapters is so high that we gladly endorse the opinion of the late Prof. Clifford—who was no mean judge upon such matters—when he writes of them as presenting to his mind "the simplest, and clearest, and most profound philosophy that was ever written upon this subject." As the three chapters together cover only 80 pages, it seems needless to render an abstract of them, so we shall only observe that although it is easy to show in them, as Mr. Mivart and others have shown, a want of appreciation of technical terms, and even of Aristotelian ideas, nowhere in the whole range of Mr. Darwin's writings is his immense power of judicious generalisation more conspicuously shown. So much is this the case that in studying these chapters we have ourselves always felt glad that Mr. Darwin was not the specialist in psychology which some of his critics seem to suppose that he ought to have been if he presumed to shake their science to its base; had he been such a specialist the great sweep of his thought might have been hindered by comparatively immaterial details.

Of the three chapters which we are considering, the most important is the one on the moral sense. As he himself says:—

"This great question (the origin of the moral sense) has been discussed by many writers of consummate ability; and my only excuse for touching upon it, is the impossibility of here passing it over; and because, so far as I know, no one has approached it exclusively from the side of natural history. The investigation possesses, also, some independent interest, as an attempt to see how far the study of the lower animals throws light on one of the highest psychical faculties of man."

The result of this investigation and study has been to give, if not a new point of departure to the science of ethics, at least a completely new conception as to the origin of the faculties with which that science has to deal; and without attempting to discuss the objections which have been raised against the doctrine, or to enumerate the points of contact between this doctrine and older ethical theories—to neither of which undertakings would our present space be adapted—we may say in general that, as in the case of instinct, so in that of conscience, we feel persuaded that Mr. Darwin's genius has been the first to bring within the grasp of human understanding

---

[1] Because the individuals which exhibit them, being neuters, can never have progeny. It is indeed surprising, as Mr. Darwin further on observes, that no one previously "advanced this demonstrative case of neuter insects against the well-known doctrine of inherited habit as advanced by Lamarck."

large classes of phenomena which had been previously wholly unintelligible.

"The Expression of the Emotions in Man and Animals" is an essay which may be more suitably mentioned in the present article than in any of the preceding. The work is a highly interesting one, not only on account of its philosophical theories, but also as an extensive accumulation of facts. "The three chief principles" enunciated by the former are: (1) "the principle of serviceable associated habits"; (2) "the principle of antithesis"; and (3) "the principle of actions due to the constitution of the Nervous System, independently from the first of the Will, and independently to a certain extent of Habit." It is shown that the first of these principles leads to the performance of actions expressive of emotions because "certain complex actions are of direct or indirect service under certain states of mind, in order to relieve or gratify certain sensations, desires, &c.; and whenever the same state of mind is induced, however feebly, there is a tendency through the force of habit and association for the same movements to be performed, though they may not then be of the least use." The second principle arises because, "when a directly opposite state of mind is induced, there is a strong and involuntary tendency to the performance of movements of a directly opposite nature, though these are of no use; and such movements are in some cases highly expressive." And the third principle occurs because "when the sensorium is strongly excited, nerve-force is generated in excess, and is transmitted in certain definite directions, depending on the connection of the nerve-cells, and partly on habit." All these principles are more or less well substantiated by large bodies of facts, and although the essay, from the nature of its subject-matter, is necessarily not of so transforming a character in psychology as those which we have already considered, and although we may doubt whether it gives a full explanation of every display of expressive movement, we think there can be no reasonable question that the three principles above quoted are shown to be true principles, and therefore that the essay is completely successful within the scope of its purposes.

Lastly, we have to allude to the brief paper published in *Mind* on the psychogenesis of a child. These notes were not published till long after they were taken, so that Mr. Darwin was the first observer, by many years, in a department of psychology which—owing chiefly to the attention which his other writings have directed to the phenomena of evolution—is now being very fully explored. The observations relate entirely to matters of fact, and display the same qualities of thoughtfulness and accuracy which are so conspicuous in all his other work.

On the whole, then, we must say that Mr. Darwin has left as broad and deep a mark upon Psychology as he has upon Geology, Botany, and Zoology. Groups of facts which previously seemed to be separate, are now seen to be bound together in the most intimate manner; and some of what must be regarded as the first principles of the science, hitherto unsuspected, have been brought to light. No longer is it enough to say that such and such actions are the result of instinct, and so beyond the reach of explanation; for now the very thing to be explained is the character and origin of the instinct—the causes which led to its development, its continuance, its precision, and its use. No longer is it enough to consider the instincts manifested by an animal, or group of animals, as an isolated body of phenomena, devoid of any scientific meaning because standing out of relation to any known causes; for now the whole scientific import of instincts as manifested by one animal depends on the degree in which they are connected by general principles of causation with the instincts that are manifested by other animals. And not only in respect of instincts, but also in respect of intelligence, the science of comparative psychology may be said for the first time really to have begun with the discovery of the general causes in question; while from the simplest reflex actions, up to the most recondite processes of reason and the most imperious dictates of conscience, we are able to trace a continuity of development. A revelation of truth so extensive as this in the department of science which, in most nearly touching the personality of man, is of most importance for man to explore, cannot fail to justify the anticipations of the revealer, who in referring to psychology, could "in the future see open fields for far more important researches" than those relating to geology and biology. If the proper study of mankind is man, Mr. Darwin has done more than any other human being to further the most desirable kind of learning, for it is through him that humanity in our generation has first been able to begin its response to the precept of antiquity —*know thyself.*

The series of brief articles whereby we have endeavoured to take a sort of bird's eye view of Mr. Darwin's great and many labours have now drawn to a close. But we cannot finish this very rudimentary sketch of his work without alluding once more to what was said in the opening paragraphs of the series, and which cannot be more terseley repeated than in Mr. Darwin's own words there quoted with reference to Prof. Henslow:—"Reflecting over his character with gratitude and reverence, his moral attributes rise, as they should do in the highest character, in pre-eminence over his intellect."

In the gratitude and reverence which we feel in a measure never to be expressed, we sometimes regret that the ill-health which led to his seclusion prevented the extraordinary beauty of his character from being more generally known by personal intercourse. True it is that the world has shown in a wonderful degree a just appreciation of this character, so that many thousands in many nations who had never even seen the man heard that Charles Darwin was dead with a shock like that which follows such an announcement in the case of a well-loved friend; still it seems almost sad that when such an exalted character has lived, it should only have been to so comparatively few of us that the last farewell over the open grave at Westminster implied a severance of feelings which had never been formed before, and which, while ever living among the most hallowed lights of memory, we know too well can never be formed again. But to those of us who have now to mourn so unspeakable a loss, it is some consolation to think, while much that was sweetest and much that was noblest in our lives has ended in that death, his great life and finished work still stand before our view; and in regarding them we may almost bring our hearts to cry—Not for him, but for ourselves, we weep.

IMITATION CHEESE

IN NATURE, vol. xxv. p. 269, we gave an account of the mode of manufacture of "butterine," a compound containing about 90 per cent. of a mixture of animal fats known as "oleomargarine."

"Butterine," as the name would imply, is an imitation butter which is largely imported into this country from America and from Holland. "Oleomargarine" is principally made in the United States by the patented process of Mége-Mouries, which consists in heating disintegrated suet to a temperature of 120° F., when a clear yellow oil is (to borrow a term of the metallurgists) "liquated out." This is allowed to solidify, and "refined" by subjecting it to pressure at a temperature of about 90° F. "Oleomargarine" is converted into "butterine" by adding about 10 per cent. of milk to it and churning the mixture, colouring the product with annetto, and rolling it in ice to "set" it. Some idea of the development of this industry may be gleaned from the fact that Mr. Nimmo, the chief of the United States Statistical Department, reported that the export of oleomargarine for the year ending June 30, 1880, was close upon 19,000,000 pounds. And this is probably under-estimated, as it is certain that considerable quantities of "butterine" passed through the Customs under the designation of butter. It is not very easy to get data which are altogether trustworthy; but looking to the rate of increase furnished by the statistics of previous years, it is probable that the present export of oleomargarine from America is not less than from 25,000,000 to 30,000,000 lbs. per annum. Oleomargarine was the subject of some discussion in the House of Commons during the last session, and the matter was again brought up a few nights ago in the form of some interrogatories addressed to the President of the Board of Trade.

It appears that oleomargarine has recently taken a new departure, and that its use is no longer confined to the manufacture of "butter substitute," or "butterine." Our ingenious friends on the other side of the Atlantic have discovered that a mixture of oleomargarine and blue skim milk make what Mr. H. M. Jenkins, the Secretary of the Royal Agricultural Society of England describes as an excellent imitation of "American Cheddar." Indeed, so excellent is the imitation, that competent judges in the City and elsewhere informed Mr. Jenkins that unless they had been told, they could not have distinguished the oleomargarine cheese from ordinary American cheese, and that they valued it from 52*s.* to 56*s.* per cwt. wholesale, and from 8*d.* to 9*d.* per lb. retail. American cheese of presumably legitimate origin is of course a well-established article of importation into this country; the estimated value of the cheese we import is upwards of 5,000,000*l.*, of which at least one-half is credited to the United States; and "American Cheddar," "American Cheshire," "American Stilton," &c., are well-recognised terms among retail provision dealers. We are now to have "Imitation American Cheddar," "Imitation American Stilton"—Stilton and Cheddar, in fact, several times removed; and Mr. Jenkins tells us that a very extensive trade will be shortly established in these articles, provided that their quality proves to be sufficiently good for the English market. Samples of these imitation cheeses have been examined by Dr. Voelcker, the chemist to the Royal Agricultural Society, who pronounces them to be perfectly wholesome articles of food. If the "oleomargarine" which enters into their composition be obtained from healthy fat or suet, there is, of course, no reason to doubt their wholesomeness or their alimentary value. Provided that the proportion of skim milk and oleomargarine be properly adjusted, the composition of the imitation cheese will differ but slightly from that of the best English made cheese, and will, so far as its nutritive value goes, be probably preferable to the ordinary skim milk cheeses of this country, or even to the more esteemed varieties of Gruyère and Parmesan. "Imitation factory cheese," as Americans call the new produce, will, of course, be almost entirely wanting in the characteristic fats of milk, such as butyrin, caprin, and caproin, to the decomposition of which the ripening and flavour of good cheese is mainly due. As is well known, hard solid cheese, in which the proportion of fat is comparatively low, ripens but slowly, and unless artificially flavoured, as in the case of Parmesan, acquires little or no piquancy. On the other hand, a rich cheese rapidly loses the acid reaction which it has when new; the casein and the fat suffer change, and the fatty acids thus formed combine with the products of the decomposition of the nitrogenous constituents giving rise to compounds, which, when accompanied by a due proportion of the green mould of *Aspergillus glaucus*, or the red mould of *Sporendonema casei*, afford the piquant flavour and aroma of the more valuable varieties of cheese. Such cheeses, however, soon run into putrefactive decay; they become strongly alkaline, and may even give rise to poisonous products. The fats of "oleomargarine" consist mainly of olein, stearine and their congeners, and are much more stable compounds; hence the cheese in which these bodies function will ripen comparatively slowly, and would of themselves never acquire the flavour of such rich cheeses as Stilton or Double Gloucester. Still art can do much, and he would be rash who would attempt to set a limit to American ingenuity; but we may at least hope that *Aspergillus* and *Sporendonema* may prove to be beyond the reach of the imitative power of the Transatlantic cheese-merchant.

T. E. THORPE

THE IRRAWADDI RIVER

Report on the Irrawaddi River. Part I. Hydrography of the Irrawaddi River. Part II. Hydrology of the Irrawaddi River. Part III. Hydraulics of the Irrawaddi. Part IV. Hydraulic Works connected with the Nawoon River. Parts I. and II. (in one vol.), 195 pp.; Part III., 227 pp.; Part IV., 151 pp. fol. By R. Gordon, Esq., M.I.C.E., &c. (Rangoon, 1879-80.)

THIS is a valuable Monograph on the Irrawaddi River by the Executive Engineer of the great Embankment Works of the Irrawaddi Delta, the well-known experimenter and writer on river hydraulics. The mode of publication does not do justice to the great labour and research shown in so large a work (573 pp. folio). It is apparently a Government Report, written in the period 1877-80, and printed at the Government Secretariat Press, Rangoon, in 1879-80. Great allowances must always be made for the difficulties in proper correction of the proofs of a work published at a small native press at a great distance from the author. Still the misprints in this work are quite unusually numerous, sometimes *three* in a single line of French or German, sometimes *four* in a single page of ordinary matter; this throws some doubt on the accuracy of the printed Tables (which cover about 130 pp. folio). The complete Report must have included about 29 plates (constant reference being made to them), but only three are published; the absence of these plates makes it often difficult, sometimes impossible to follow the author's argument. Again, the want of uniform transliteration of proper names causes difficulty in identifying unfamiliar places, the same place being often spelt in two or more ways (*e.g.* Shoaygheen, Shwaygheen, Shwégyeen, &c.). There is a too frequent use of local words (*e.g. choung* = river, *eng* = lake, &c.), and also of odd un-English words (*e.g.* divagation, prescinding, &c.). These are, however, trifling drawbacks compared with the fact that the work is one of great value, combining the results of unusual knowledge of the literature about the Irrawaddi with probably unique practical knowledge of the Irrawaddi Delta.

The work contains three very distinct subjects: 1, the question of the sources of the Irrawaddi (Parts I. and II.); 2, the hydraulic works on the Irrawaddi (Part III.) and Nawoon Rivers (Part IV.); 3, the theory of the flow of water in rivers (Parts III. and IV.).

Sources of the Irrawaddi.—Parts I. and II. form a monograph on the vexed question of the lower course of the great Thibetan River (Tsanpou or Sanpo); its upper course from west to east within the heart of the Himálya mountains has long been roughly known (by travellers' reports), but its lower course beyond the Himálya is still strangely obscure. The Indian Survey maps have long shown the Sanpo as continuous with the Brahmaputra. But the author adopts the view of the great French geographer, D'Anville (*circa* 1730), that the Sanpo is the upper course of the Irrawaddi. He discusses at great length the general features of the Thibetan plateau and of the Brahmaputra and Irrawaddi valleys, especially as to the distribution of mountain and valley, and as to rainfall and river discharges. The chief argument is that just above the *débouchure* of the highest known large affluent (the Mogoung), a little above Bhámo, at a distance of 800 miles from the sea, the Irrawaddi is still an immense river 1000 yards wide and with a flood discharge of over 1,000,000 cubic feet per second, and therefore requiring a large drainage area above Bhámo. Now within 100 miles above Bhámo, the five great rivers—Brahmaputra, Irrawaddi, Salween, Mekhong, and Yang-tse-kiang—are known to be contained within a narrow strip of 200 miles width; from this it would seem that the sources of the Irrawaddi must be very distant (from the want of numerous large affluents). By collating the various travellers' accounts of the Sanpo, it is shown that they are consistent with its being continuous with the Irrawaddi.

Most of this appears to have been written in 1877. But in 1877-78 the Indian Survey Department conducted some special investigations on the question; their explorers traced the Sanpo downwards to within about 100 miles of the nearest regular survey party then at work on the affluents of the Brahmaputra near the limits of British territory; this gap of 100 miles was left a *terra incognita*, so that the question was still open to conjecture. After some discussion of this later work, it is shown rather to favour the author's earlier writings.

Besides the main (geographical) argument there is much interesting matter in these two parts on the geology, meteorology, and some minor features of the Sanpo and Irrawaddi basins. The want of a good detailed map is much felt here in attempting to follow the geographical argument.

Hydraulic Works.—Parts III. and IV. deal chiefly with the (engineering question of) Embankment Works in the Delta of the Irrawaddi, intended for reclaiming the rich alluvial land and for shutting out flood water. In a practical sense this is much the most important part of the Report; but in the absence of the plates it is impossible to follow the great detail given. Still there is much of general interest admitting of some notice here.

Firstly, it is explained that most of the easily cultivable land in British Burma having been already taken up, the country—though apparently thinly populated—is actually well populated over the only good land; and that, to prevent over population, what is now really wanted is more land. In this view the reclamation of good land acquires great importance. This work in some way resembles that in the Mississippi Delta, with the important difference that the latter is a rich country with ample funds for the prosecution of large works, whilst Burma is a poor country without adequate means for the same. Indeed, the history of the works as herein set forth is throughout one of insufficient provision of funds for their rapid prosecution, and sometimes even for their proper repair; this was very disadvantageous, as of all works the timely repair of an embankment is perhaps the most urgent, as its breach may be simply disastrous.

In early days high floods on the Irrawaddi seem to have been rare; at any rate the floods of late years (1868, 1871, 1875, 1877, 1879) have all risen considerably above the highest supposed possible from local inquiry in 1862. It seems possible that this is due partly to the gradual destruction of the forests above, which causes the rainfall to be more violent while it lasts and also favours its rapid descent to the main stream, and partly to the erection of the embankments themselves which confine the floods to the main river.

A very curious instance is noticed that the 1875 and 1879 floods were *foretold* by the Burmese astrologers.

Flow of Water.—The uncertainty of hydraulic knowledge nowadays is well illustrated by the various opinions of successive engineers on the rise that would ensue in the river consequent on embanking it on both sides throughout the Delta. It is said that Col. Stoddard reported in 1869 that the rise would not exceed the average of one foot, whilst the professional adviser of Government considered that it might amount to 3 or 4 feet at Henzahda, and the author himself considered from 7 to 12 feet a probable rise. It is obvious that these results cannot be said to be any better than conjectural; their discrepancy showing that the formulæ in use for such sort of calculation were (as too often happens) inapplicable to the case in hand. The Government naturally declined to sanction the project.

The author then undertook an extensive series of direct discharge-measurements of the river nearly on the lines of the Mississippi work, viz. by direct velocity-measurements at numerous points of certain selected sites. Besides the practical value of these as necessary data for the embankment projects, the details may be of great use in the study of the flow of water. And indeed this forms the most interesting portion of the work in a scientific sense, being a mass of original experiment on the flow in a mighty river. Much credit is due to the author for the zeal with which he had these experiments carried on for several years, in the face of great difficulties and discouragements. The experiments are discussed only so far as necessary to explain the application of the results (chiefly discharge-measurements) to the embankment projects. A further special report upon the experiments themselves is promised, which should be of great value.

The velocity-measurements appear to have been entirely made with the "double-float," whereof the surface-float was a wood disc $6'' \times 6'' \times 1''$ joined by a cord $^1/_{16}''$ thick, of various lengths, to a cylindric wood sub-float $6'' \times 6'' \times 12''$ loaded with clay, and sunk to various depths from 1 to 24 mètres. At moderate depths this instrument would be pretty efficient; unfortunately the efficiency of all double-floats decreases with the depth of immersion, and at the greatest depth of 24 mètres this one must have been very inefficient; for—supposing even that the sub-float retained its most favourable (the upright) position—the relative areas of connector and sub-float exposed to direct current-action would be as 73 to 100, and to lateral current-action as 52 to 100; so that the observed velocity of the instrument was certainly not that of the current at 24 mètres depth (as it is taken to be). Notwithstanding the inherent objections to the double-float, there seems to be as yet no better instrument available for mighty rivers.

Two sorts of velocity-measurements were undertaken, viz. (1) at one mètre depth at many points (from 30 to 60) across the channel; and (2) at every mètre of depth upon selected verticals in the channel. The latter were considered the more important. This sort of work must necessarily have been very tedious in flood-seasons on a mighty river; at such times only ten complete series could be done daily; altogether about 10,000 such series were done. This is a collection of experimental data quite unique in river hydraulics, of which the author may justly be proud. From these data, together with the cross-section figure, the discharges were computed; the mode of computation seems to have been as good as the data admit of.

The mode of presenting the results is open to some objection—*e.g.* many of the velocities are carried to *four* decimals of feet per second, a degree of accuracy quite unattainable; again the discharges are given in *several* different forms, viz. in cubic feet per second, in cubic mètres, and also in tons and in "mètre-tons" per day, per month, and per year, and in some tables the unit is not stated. The author points out that one cubic mètre of water weighs about $55 \div 56$ths of a ton, so that the two measures (cubic mètres and tons) may be used indifferently with an error of less than 2 per cent., and he emphasises this coincidence by the use of a new term, "mètre-ton"; but by all modern usage this term means either the "moment of one ton of pressure at one foot leverage," or the "work done in raising one ton weight through one foot height," so that this new usage is inconvenient.

As to the theory of running water some novel views are brought forward. It is stated that, speaking broadly, two theories of flow in open channels have existed; viz. that previous to Du Buat's time the motion had been supposed due solely to pressure, and since his time has been supposed due solely to surface-slope, so that the earlier formulæ involve pressure, and the later surface slope. The author himself is the advocate of a "new theory," viz. that the motion is due to both pressure and surface-slope; his arguments appear to be chiefly two, viz. (1) that formulæ involving only one of these elements all fail under varying conditions; (2) that in many cases the ratio of the deep-seated velocities to those near the surface (which is usually < 1) rises with increase of depth of the stream, and may sometimes even exceed unity in very deep streams. These views can hardly be admitted. Firstly, as to causality, surface-slope is really only a *property* of running water, not a *cause* of motion. All change of motion is due to and is evidence of the action of some *unbalanced* force (or pressure). In the case of running water the unbalanced active force (effective in forward motion) is the part of the earth's attraction *not directly* balanced by the normal resistances (ultimately of the margin), *i.e.* the resolved part thereof parallel to the motion, the *measure* of which is $g\rho \sin i$, and actually enters into all modern hydraulic formulæ in various equivalent forms, *e.g.* as $(p - p')$, $(dp \div dx) . \delta x$, $g\rho(h - h')$, $g\rho \sin i$, $g\rho S$, &c.; it cannot therefore be said that pressure is excluded from modern formulæ (although, after substituting numerical values for $g\rho$, the evidence of it is apparently lost). In the argument it seems also to be implied that the increase of pressure due to increase of depth should cause increase of velocity, but the fact is that increase of pressure does not of itself affect motion at all, unless the increase be (at least in part) unbalanced.

An interesting series of discharge-measurements was made at three sites in concert, viz. at Saiktha, near the head of the Delta, and at Zaloon and Thapangyo, which are situate on the two largest Delta streams. There appear to be only some minor local *affluents* into and *effluents* out of the space between the upper and lower sites. It would seem therefore that the discharge-measurements at the upper and at the two lower sites together should be nearly equal; this affords a valuable test of the consistence of the results. The field work seems to have been done at *each* of the three sites on seventy-three days in 1872-73, thus giving seventy-three pretty complete results; other eighty-three days' results are also given, but these are partly interpolated, and therefore of less value. The discrepancies are sometimes very large, ranging from a *gain* of 27 per cent. to a *loss* of 15 per cent. in the daily results; most of them (97 out of 154) are on the side of gain. After making allowance for the utmost possible supply from the minor affluents between the sites (by adding in the whole rainfall all over their drainage-basins) the residual discrepancy is attributed to the "storage power" of the river area (about 305 square miles) between the sites. While there is no doubt some (temporary) "storage power," it seems more likely that most of the discrepancy is due to real error in the results themselves, the fact being that only *very rough* approximation can be expected in the discharge-measurement of mighty rivers in flood. This collection of river discharge-measurements being made in such a way as to test each other is almost unique, most published results being isolated results incapable of test.

ALLAN CUNNINGHAM

OUR BOOK SHELF

The Botanical Atlas; a Guide to the Practical Study of Plants. By D. McAlpine, F.C.S. (Edinburgh: W. and A. K. Johnston, 1882.)

THE above is the title of a publication appearing in monthly parts, each containing, in the words of the prospectus, "four beautifully coloured plates and descriptive letterpress." Part I. deals with common representatives of the natural orders *Caryophyllaceæ*, *Cruciferæ*, *Fumariaceæ*, *Geraniaceæ*, and *Labiatæ*.

We are perplexed as to the intentions of the author of this work, which is advertised as designed "for the use of medical schools and Universities." If the "Botanical Atlas" is intended to supply candidates for certain elementary examinations with the facts absolutely necessary for a "pass" certificate, it seems fair to expect accuracy in the drawings of common objects.

The author, however, appears to think otherwise; not only are there gross inaccuracies in the execution of the conspicuous figures, but the types are ill-chosen and imperfectly referred to.

In illustration of this may be noted Fig. 2, on Pl. xiv., professing to represent a vertical section of the common wallflower; the reference "long stamen," points to the anther of a short one, and the words "short stamen," are referred to a green band, which might be imagined as intended for filament, petal, or sepal, and seems to do duty for all three.

In the figures standing for other vertical sections of flowers—*e.g.* Fig. 3, Pl. xvi., and Figs. 2 and 3, Pl. xxiii.—no one can avoid noticing the mysterious vagueness in the lower portions of the drawings; the same remark applies to the sections on Pl. xv. Is the author undetermined as to the relations of the parts composing the andrœcium and gynœcium, or does he expect students, for whom elaborately-coloured drawings of sepals and petals have been prepared, to discover the forms and relations of the smaller essential organs without aid—or, rather, in spite of the misleading caricatures here placed like pitfalls in his path?

Similar faults are apparent in the diagrammatic plans of the flowers, and one wonders at the ingenuity displayed in going so far out of the way to prepare imperfect and inaccurate drawings of common objects.

Among other equally ingenious misrepresentations may be named Figs. 9 and 10, Pl. xv.—the marvellous streaks in a somewhat oval frame (Fig. 11, Pl. xvi.) supposed to represent a longitudinal section of the seed of *Geranium*, the incomprehensible *stigma* in Fig. 8, Pl. xxiii., with reference to which we cannot agree with the author when he says: "The figures will show the arrangement of the parts better than any description."

Passing over such errors as Nostoe, Hydrodietyon—possibly printer's mistakes—and the questionable mixtures of Latin and English names, we may notice one or two specimens of description appended to these gaily-tinted plates. We are told, without further remark: "The form and arrangement of the different parts (Fumitory) are evidently suggestive of some purpose." Also, the description of the wallflower commences: "Wallflower is a universal favourite, no less from its beautiful colour than from its sweet smell," and then passes on to a highly condensed and imperfect synopsis. We are told that the "Campion" "also smells in the evening in order to guide and attract insects," and that in Herb Robert "the stem forks a deal, and is very brittle at the joints."

Such drawings and writing speak for themselves. We can only express the hope that if the other parts are published, more attention will be paid to accurate delineation and exhaustive description, and less to merely gaudy colouring. So far, the "Botanical Atlas" must be considered as but a very inefficient and faulty "guide to the practical study of plants." W.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Magnetic Storms of 1882, April

THE Astronomer Royal having received from Mr. Charles Carpmael, superintendent of the Meteorological Office at Toronto, Canada, copies of the Toronto records of the double magnetic storm of April last, has had them compared generally with the Greenwich records. Some results of this comparison I am desired by him to communicate to you for insertion, if you think proper, in the columns of NATURE.

The records comprise traces of the changes of magnetic declination, horizontal force, and vertical force. The commencement of disturbance on April 16 was sudden, in all elements, as was also the renewal of disturbance on April 19. Measuring out the times, both for Greenwich and Toronto, the following results are found:—

Element.	Toronto time of commencement of disturbance. h. m.	Corresponding Greenwich time. h. m.	Greenwich time of commencement of disturbance. h. m.
Declination ...	April 16, 6 17 ...	16, 11 35 ...	April 16, 11 31
Hor. Force ...	,, 6 15 ...	,, 11 33 ...	,, 11 31
Ver. Force ...	,, 6 16 ...	,, 11 34 ...	,, 11 35
Means		April 16, 11 34 ...	April 16, 11 32
Declination ...	April 19, 10 15 ...	19, 15 33 ...	April 19, 15 34
Hor. Force ...	,, 10 16 ...	,, 15 34 ...	,, 15 34
Ver. Force ...	,, 10 16 ...	,, 15 34 ...	,, 15 37
Means		April 19, 15 34 ...	April 19, 15 35

The times are mean solar. In the first case the mean of the Greenwich times is but 2m. earlier than that of the reduced Toronto times; in the second case 1m. later, indicating no real difference. This confirms, what has been before observed, that in times of storm the commencement of disturbance at different places appears to be simultaneous.

As regards the variations registered during the progress of the storm there does not seem to be any very close correspondence between the records of the two places excepting in one particular, the occurrence of a very remarkable decrease of horizontal force, soon after the first outbreak on April 16, which continued for some hours, and is a striking feature in both records.

WILLIAM ELLIS

Royal Observatory, Greenwich, June 16

Earthquakes in China

PLUSIEURS secousses de tremblement de terre ressenties en Chine pendant l'année 1881 ont été rapportées dans les journaux de Shanghai, de Hongkong et de l'étranger. Voici sur deux d'entr'eux quelques circonstances toutes particulières qui sont venues à ma connaissance et dont on n'a pas parlé.

Le 20 Juillet, un peu après 9h du soir, une secousse assez forte ébranla la ville de Tchong-kin, capitale de la Province de Sze-tchuen, longitude 104° E. de Paris; immédiatement après, écrit un Missionnaire, la ville fur couverte d'une brume tellement dense qu'on ne voyait pas à 10 pieds devant soi; de plus une odeur de soufre très sensible se repandit partout. On prit tout d'abord cette brume et cette odeur pour un indice d'incendie;

mais on le chercha en vain. La terreur était d'autant plus grande dans la ville que le peuple, à cette époque même, multipliait les superstitions, et les sacrifices en l'bonneur des divinités protectrices contre les incendies. Aussi le grand mandarin de Tchong-kin avait prohibé la vente et l'usage des allumettes chimiques importées par les étrangers (yang ha) et celui du pétrole (yang ieon) qui avaient naguère occasionée une terrible conflagration.

Voici une note de Mr. Harding, l'ingénieur chargé d'elever un phare à la pointe sud de l'île Formose.—Le 11 Décembre 1881, vers 4h du matin, trois chocs distincts de tremblement de terre furent ressentis." The first, of which the motion was oscillating, and which was the most severe, lasted abnut 3 to 4 seconds; then an interval of about 10 seconds followed by the second shock—an interval of 1 or 2 seconds, followed by the third shock—direction from S.S.W to N.N.E. These shocks, which were of great severity, were also felt in Tai-wan-foo and Takow (environ 75 et 52 milles an nord nord-ouest du cap sud). The water at South Cape rose 16 feet, causing great destruction to the cargo boats moored near the beach, and was accompanied by a heavy southerly swell. The water which at spring tides only rises 3 feet 8 inches, had resumed its ordinary level at 7 a.m.

On March 19, 1882, at about 5 p m., a slight shock of earthquake (toujours au cap sud), with a gentle oscillating motion from south to north. Duration of shock about 3 seconds."

J'ai pensé que ces curieux faits intéresseraient les lecteurs de NATURE.

Le Directeur de l'Observatoire,
MARC DECHEVRENS, S.J.

Observatoire de Zi-ka-wei, près Shanghai, Chine, Avril 25

P.S.—Une grave perturbation magnétique a été enregistrée à Zi-ka-wei le 17 Avril dernier. Elle débuta brusquement à 7h. 36m. du matin (temps moyen de Zi-ka-wei, longitude 8h. 5m. 50s. de Gr.) par une augmentation de la composante horizontale de l'intensité et une diminution de la déclinaison. Vers 8h. un mouvement inverse commença pour se continuer avec de larges ondulations mêlées de saccades brusques et nombreuses jusqu'á 2h. 22m. de l'après midi, moment où la déclinaison atteignit son maximum. Entre le minimum, qui fut enregistré quelques minutes après le début de la perturbation, et ce maximum de 2h. 22m. la déclinaison a varié de 21'·1, valeur considérable à Zi-ka-wei. La composante horizontale eut son minimum d'intensité (apparent à cause de la variation de température) d'abord á 4h. 20m. du soir, puis encore à 7h. 20m. du soir. Ou peut se rendre compte de l'énorme baisse enregistrée en cette occasion, en sachant que le 19, par exemple. où la variation de la composante fut normale, la courbe photographiée à une amplitude totale de 15 millim, tandis que le 17 pendant la perturbation la variation totale s'éleva à 76 millim. entre 7h. 36m. du matin et 4h. 20m. du soir. Les grandes ondulations se dessinèrent pendant le minimum d'intensité entre 2h. du soir et 10h. du soir. Vers 11h. 30m. du soir la composante se releva très-brusquement, oscilla encore 3 ou 4 fois ce vers 3h. du matin 18 la perturbation était finie. A cette augmentation brusque d'intensité correspondit une diminution non moins rapide de la déclinaison, suivie aussitôt après d'une forte augmentation qui mit aussi fin à la perturbation de cette boussole.

Pendant tout ce temps l'aimant de la composante verticale oscilla constamment mais dans de très-petites limites; il n'y eut que deux ondulations qui se dessinèrent assez nettement, l'une entre 8¼ et 8½ du soir l'autre à 11.30.

Le 20 Avril, nouvelle perturbation aussi intéressante commençant avec une soudaineté et une violence extraordinaire à 11h. 40m. du matin par une énorme diminution de la composante horizontale, suivie de sauts ou d'ondulations amples et assez rapides. Inutile de dire que la déclinaison a varié proportionellement et en sens inverse. Le maximum de déclinaison fut enregistré à 3h. 43m. de l'après-midi; entre le minimum normal de 9h. et ce maximum de l'après-midi la variation à été de 13'·2 seulement. La perturbation prit fin à 2h. 20m. du matin le 21, quoique la déclinaison continuât à être irrégulière dans la journee.

A cette double perturbation magnétique ont correspondu des troubles profonds dans toutes les lignes telégraphiques, marines ou terrestes, de l'extrême Orient, de Singapore et Manille jusqu'à Tientsin. Les moments ou les courants perturbateurs furent observés furent surtout, le 17, entre 10h. et midi (Nagasaki-Shanghai Shanghai-Hongkong), à midi 50m. (Hongkong-Amoy-Shanghai), à ce moment la correspondance entre Hongkong, Manille, et Singapore entiérement interrompue; entre 2h. 5m. et 2h. 20m. Shanghai Amoy). Le 20, à midi (Shanghai-Nagasaki).

Tout cela indique pour l'Europe de belles aurore boréales. Ici rien.

Non-Electric Incandescent Lamps

IT is I believe well known that a method of obtaining light by means of incandescent platinum was patented by A. Cruckshanks in 1839. The following extracts from his specification (No. 8141) will, I think, show that there is no essential difference between the lamp devised by Prof. Regnard (NATURE, vol. xxvi. p. 108) and the invention of the patentee, which is described as follows:—

"In order to increase the light obtained from substances that are rich in carbon and to obtain light from gases and vapours that do not contain the proportions of carbon necessary to produce a bright flame, I construct a cage of fine platina wire gauze or network of the form of the flame and just so much smaller than the flame, that it may be entirely immersed in the outer portion of it, where it will soon become intensely ignited."

Further on it is stated that the platinum (covered with lime) may be heated by jets of the "vapour of inflammable liquids mixed with atmospheric air," and the patentee says that "the most advantageous method in practice" of obtaining the mixture "is to pass a current of air through such liquid."

The use of incandescent platinum as a source of light was again patented in 1849 by Gillard, and put in practice at Narbonne and some other small towns in France, but after a fair trial the experiment was abandoned (see King's "Coal Gas," vol. i. p. 53).

F. M. SEXTON

61, Barrington Road, S.W., June 12

Conservation of Solar Energy

THE views of Dr. C. William Siemens suggest a consideration of the influence of solar rotation upon the æthereal atmosphere, at various distances from sun's centre.

Laplace's limit of equal rotary and planetary velocity is at $36{\cdot}35\, r_{\circ}$, $r_{\circ}$, being sun's semidiameter. The centrifugal force of rotation at that limit would be 1321·3 times as great as at sun's surface, while the centripetal force of gravitation is only $\frac{1}{1321{\cdot}3}$ as great. The lately-published photographs of the solar eclipse indicate an atmospheric oblateness which may be due to the equilibrating tendencies of the two opposing forces.

If the æthereal disturbances from this source are not sufficient to account for luminous and thermal vibrations, we may look next to the velocity which the subsiding particles would acquire in falling from the equatorial limit to the solar poles. If there were no resistance, this velocity would be

$$\left(\frac{35{\cdot}35}{36{\cdot}35} \times 2gr\right)^{\frac{1}{2}} = 376{\cdot}8 \text{ miles per second.}$$

Any diminution of this velocity by resistance would be converted into heat.

If we apply Coulomb's formula of torsional elasticity, $f = \frac{\pi a^2 lW}{2gt}$, to solar rotation, W may represent sun's mass, a the coefficient of the radius of torsion, f the coefficient of torsion, g gravitating acceleration at sun's equatorial surface, t time of oscillation when the force of torsion is removed, or time of a solar half-rotation. Then

$$f = \frac{m}{2} = \frac{W}{2} \cdot \frac{\pi^2 a^2 r_{\circ}}{gt^2}; \therefore \pi a^2 r_{\circ} = gt^2 = \pi^2 l.$$

But g', or the projectile velocity that is represented by sun's rotary oscillation, is *the velocity of light*; gt^2 is the modulus of light at sun's equatorial surface; $a^2 r_0$ is the theoretical length of a pendulum, at sun's surface, which would oscillate once in each half rotation; $ar_{\circ}$ is the length of an equatorial radius rotating with sun, and having the superficial orbital velocity, $\sqrt{gr}$, at its emote extremity.

PLINY EARLE CHASE

May 27

The Function of the Ears in the Perception of Direction

UNFORTUNATELY, through the bungling of my late agents, I am unable to refer to NATURE, vol. xxiv. p. 499, as quoted by

Mr. S. E. Peal, I may, therefore, be communicating stale information; but as it is the result of personal experience, what I have to relate may be of some use as confirmatory of statements of others. Mr. Peal would not be able accurately to estimate direction, unless the sense of hearing—the capacity to receive sound—was precisely equal and similar in each ear. A greater sensibility in one than in the other, would incline him to the right, or the left, as the case might be.

Few people know that they may be partially deaf on one side, and yet not perceive it, just as some are right- or left-eyed, without knowing it. A good test is a watch slid along a two-foot rule, the end of which touches the cheek. The watch is moved away, inch by inch, till the ticking is no longer audible—if the distance is the same on both sides, the sensibility of each ear is of course equal.

I shall not forget my horror when my medical man, applying this test, showed that while with my right ear I could distinguish the ticks far beyond the 2 feet, my left ear was impervious to the sound until within an inch or two of the watch. Hearing on that side has now totally ceased, and the result is *I have not the slightest idea of the direction of sound.* I can hear certain sounds (for I am becoming deaf on the right side also), but to whichever side I incline my right ear, from thence do I fancy the sound to come.

To me, with my passion for ornithology, it is a terrible deprivation. In my youth my senses were intensely acute. I could instantly detect and proceed to the faintest note uttered by a bird in the forest. Now the loudest call only puzzles me the more. But I was a long time before I found this out. I fancied more than once that the bird I was pursuing had powers of ventriloquism; then that there were two or more, calling from different directions. As soon, however, as I found, as before stated, that I was deaf on one side, I began experimenting on myself, and quickly arrived at the conclusion that in order to estimate direction, both ears needed to be equally sensitive.

A curious instance of correct judgment as to direction and distance of sound is given by one of the South African explorers, Green, I think. He had been much annoyed by a lion which roared round his camp. Taking his rifle and some of his native followers, he went outside in the direction of the sound. Halting, they listened intently, and at the next roar caught the exact direction, and judged the animal to be at (I think) about 300 yards. Carefully levelling his rifle, he fired, and had the satisfaction of hearing the well-known "thud" of the bullet, and a change of note from the midnight serenader. Next morning showed traces of blood, and following up the track they found, and despatched the wounded beast.

Colour-blindness is represented in the other sense, by an inability to distinguish certain sounds. That this is caused by partial deafness, I am now pretty well certain. My father-in-law, who never knew he was deaf, never heard the chirrup of the cricket, and I now find I cannot do so. Only last night my wife observed "what a noise the crickets are making," to me there was unbroken silence as regarded outward sounds. I only heard the continuous "buzzing" that sounds in my head, augmented by the regular "thud thud" of my pulse.

I have a clock, the hours of which strike on a sweet-toned, metallic bell. If my right ear is turned towards it, at a moderate distance, I hear the ringing note; if turned away, I am only conscious of the "burr" of the works, and a dull "thud, thud," denoting the stroke. Why do I hear the "burr," which is not so loud, or clear, as the metallic "ting"? That wave of sound seems to pass by and not affect me; it is like the sharp note of the cricket.

The cause why certain sounds are inaudible to certain ears is a subject well worthy of investigation, as bearing on the placing of sentries or outposts at night, in time of war; also for sportsmen hunting large dangerous game. E. L. LAYARD

British Consulate, Noumea, New Caledonia, April 7

Jamaica Petrel

MR. D. MORRIS asks (NATURE, vol. xxv. p. 151) for some clue to the locality and general character of the nesting-places of petrels. As I fail to find any reply in your pages up to January 19, I venture to send my mite by way of response to Mr. Morris.

Most of the petrels (*Æstrelata*), the Storm Petrels (*Thalassidroma*) and the Shearwaters (*Puffinus*) breed in holes in the ground, excavated by themselves; sometimes on small islands, at other times on high mountains, at considerable distances from the sea. Their movements to and fro are almost always performed at night, and as they are capable of a very rapid flight, a distance of fifteen or twenty miles is quickly traversed.

Here, in New Caledonia, the well-known *Æstrelata mollis* breeds on the summit of Mont Mou (about 4000 feet) in January-March, in great numbers, laying one white egg, as usual. I am informed that in some places the ground is honeycombed with their burrows. I am also told that during the non-breeding season numbers come to roost in their old holes.

The larger, *Æ. rostrata*, Peall, nests in similar places, but at a much less elevation, on the Island of Uen, the most southern portion of New Caledonia, and hardly divided from it by the celebrated Wodin passage.

Other species are said to frequent other mountains in the interior, but I have no personal knowledge of them.

In Fiji I obtained *Puffinus ungax*, which bred far away in the mountainous interior, and there are other true petrels which do the same.

Vast numbers of various petrels and shearwaters are found in these seas, and I fancy all burrow, more or less, in the earth, to lay their eggs. Of the "Great Grey Petrel" (*Adamastor cinerea*) Capt. Hutton says, that it "burrows horizontally into the wet, peaty earth" (of Kerguelen's land) "from two to eighteen feet."

That the "Jamaica Petrel" resorts to the Blue Mountain range of Jamaica, for the purposes of breeding, I have not the smallest doubt, and if the holes are examined at the right time of year, I feel sure eggs will be found. The birds probably do use the holes as resting places, during certain periods of the year. They do not, however, *lay their eggs at sea!* and sooner or later Mr. Morris may be sure of finding eggs, though he may not find much of a nest.

The breeding of the Mutton Bird (*Puffinus brevicaudus*) on many of the Australian islands has been often described. Its burrows render walking positively dangerous. If Mr. Morris can refer to Gould's "Birds of Australia," he will find much information on this head. E. L. LAYARD

British Consulate, Noumea, April 10

THE REGNARD INCANDESCENT LAMP.—In reply to several correspondents who find a difficulty in the use of petroleum for this lamp, we think they may be more successful with benzoline.

DOUBLE STARS[1]

II.

WE are in possession of numerous methods of computing double star orbits. Sir John Herschel gave one of the first solutions of this problem, and his method has been used more than any other up to this, and so far from becoming obsolete, it is yearly gaining ground at the cost of the methods that have been proposed elsewhere. It starts with the construction of the orbit, which the companion appears to describe round the main star. It is clear that as the planes of the orbits may be inclined in every direction in space, we see only the projection of the real orbits on the heavens, but this, as well as every other projection of an ellipse on a plane surface, is another ellipse, though the main star does no longer appear situated in the focus. Five points determine an ellipse, if we therefore possess five complete observations, we can determine the apparent ellipse. Now the observations are not perfectly accurate, but the calculus of probabilities furnishes us with means to ascertain the most probable ellipse from a great number of observations, to which different weight may be attributed, according to their reliability, as far as known. But at Herschel's time, though the angles had been fairly observed, the measurement of these minute distances was still in its infancy. He, in consequence, threw them away, and computed distances by aid of the Keplerian law referred to above, from the angular velocities, concluded from a comparison of observations separated by moderate intervals. He improved the angles in the following way:—On a paper neatly divided into squares, he lays down a

---

[1] Continued from p. 155.

point for every observed angle of position, the epoch in years and decimals being measured as an abscissa along the horizontal lines, and the angle in degrees as an ordinate along the vertical ones. A series of points are thus obtained, which, if the observations were exact, would necessarily admit of a regular curve being drawn through them, whose nature is of course determined by the laws of elliptic motion, and one of whose essential characters is to have within those limits of the abscissa, which correspond to a whole period of revolution (that is, to a difference of 360 units in the ordinates), in some cases two, in some four, points of contrary flexure, but never more than the latter, nor fewer than the former, and to have, moreover, in all its points, a peculiarly graceful and flowing outline. The errors of observation, however, prevent the drawing of such a curve through all the points. It must be drawn with a free but careful hand, not through, but among the points, and so that it shall deviate less from every point, according as it is more or less reliable. Now after Herschel's time the accuracy of the observed distances has wonderfully improved, and we are therefore able to draw another curve representing the distances as ordinates, which then ought to agree with those deduced from the angles, and the angles ought to agree with those deducible by aid of integral calculus from the distances. The curves must be varied till they thus mutually support each other, and then we may construct any number of points of the apparent orbit by reading off the angles and distances for the corresponding epochs on the curves, and if we find the arc described sufficiently extensive, the apparent ellipse is simply drawn as nearly as possible through them. From the apparent orbit the elements of the real orbit, described in space, are then determined. These are seven in number :—

a. The major semi-axis, expressed in seconds of arc, *i.e.* the angle under which their mean mutual distance would appear if placed perpendicular to the line of vision, *i.e.* the straight line joining us with the star.

ϵ. The eccentricity of the real ellipse.

γ. The inclination of the plane of the real orbit to the plane perpendicular upon the line of vision.

Ω. The node, *i.e.* the angle of position of the line in which the plane of the orbit intersects the plane perpendicular upon the line of vision.

π. The longitude of the projected peri-astron, *i.e.* the angle of position of the companion at the epoch of its actual nearest approach to the main star.

T. The epoch, when the nearest approach in space occurs.

P. The period of revolution, *i.e.* the time it takes the companion to complete an entire revolution round the main star.

It is impossible to say what part of the orbit is inclined towards us, and what is removed from us,[1] we cannot therefore, distinguish between an ascending and a descending node.

Both before and after Herschel's investigations, several methods of calculating double-star orbits have been proposed. Savary, at Arago's request, was the first who gave an analytical determination of an orbit from five points. He also proposed a method, subsequently improved by Encke, for calculating the seven elements of the real orbit from four complete observations. These furnish eight co-ordinates corresponding to known epochs, and as only seven quantities, the elements are sought, the problem is over-determined. It has to be solved with different values of one of the data, in order that all the other data may be represented. The case is, at the time it generally was possible to obtain but three complete positions from the discussion of modern observations, while the fourth, depending upon Herschel's measures, gives seldom even an approximate value of the distance. After that, a longer series of angles had become available. Klinkerfues proposed to determine at once the seven elements from six observed angles, and at least one distance. The dimensions of the orbit could evidently not be obtained without the aid of observed dimensions, though all the other elements can be derived from the angles. It sometimes occurs that the companion moves in an orbit, the edge of which is turned towards us. The inclination is then about ninety degrees, and all the angles are nearly equal to, or half a circumference different from the longitude of the node. We are then obliged to make more extensive use of the distances. Several analytical methods have been adopted to this contingency, which has actually occurred in a few cases. It seldom happens that an orbit founded upon a few positions, even if these are distributed over a great part of the arc described, is the most accurate that could possibly be deduced from all the observations at our disposal. It is therefore advisable to finally correct the elements according to the rules of the calculus of probabilities, so that the errors ultimately left behind in the representation of the observed places, may, taking into account their relative accuracy and their different peculiarities, be as small as possible. In this country, Hind, one of the greatest authorities on anything relating to double stars, has made most extensive calculations of this nature.

The number of those double stars whose orbits can be computed is limited to between thirty and forty. The time during which micrometric measures have been made is so short, that one but seldom can make anything like a correct guess of what the whole orbit may turn out to be like, when the period is above three hundred years ; and even so, the peri-astron passage must happen to fall within a hundred years from now ; that is, if the eccentricity is not unusually small. The eccentricity of these orbits is generally large, and it appears to be larger the greater the period and the greater the axis is. Now in the cases—by far the most frequent—where the measures do not embrace a larger part of the orbit, we represent the motion of the companion by formulæ, deduced in accordance with the proportionality of the areas with the times. These formulæ suffice to foretell the co-ordinates for some few years to come, and they are interesting in other respects, too. Thus, if the distance of a double star from the solar system were known to us, we would also know the dimensions of the orbit in miles, and then we could calculate its mass by aid of Kepler's laws. Now their distances from us are not known, but if we assume the mass to be on an average *e.g.* about three times the mass of the sun, then we obtain—if we make the further assumption that the distance actually measured in seconds of arc between the components is in an average of a very great number of stars equal to their mean distance from each other—from the period of revolution (concluded from the variation of the angle) through the inverse calculation their distance from us. Now these hypotheses can only be used in discussing the results of an average of a great number of systems that have certain characters in common, *e.g.* brightness, colour, or distance. I am at present engaged with such researches, from which I hope to arrive at interesting results.

Most of the double stars, that so far have been found to revolve, are close and more or less difficult objects. Few of them are more than six and a half seconds of arc asunder. The components are in most cases of about the same brightness, but the companion is, on the whole, smaller, the greater the distance.

There are two kinds of revolving double stars. The first of them consists of bodies whose colours are strictly identical, whereas the second consists of bodies whose colour is generally complementary. The principal star in both cases is white or yellow—white stars preponderating in the first case, yellows in the second. In systems of

---

[1] This could be ascertained if we could at any time observe the speed in miles per second with which the companion approaches to or recedes from us in the line of vision. Spectroscopists are making some progress in similar researches, but their apparatus are not as yet sufficient for our purpose.

the latter kind, the companion is generally bluish, and the number of blue companions increases rapidly with the distance, so that the close pairs are generally of the same, more or less white colour, and not very different in magnitude, whereas the wide pairs are of complementary colours, and the companion much fainter than the primary. We see then that the brightness is, on the whole, more different, the more different the colour is—a circumstance first pointed out by Struve. Now it is well known that the colour of a solid or liquid cooling body passes from white through yellow to red, and these are the colours in which the single stars, without exception, appear to us, whereas the blue and purple stars are found only as small companions to brighter stars. Holden, in Washington, has suggested that these colours are due to absorptive atmospheres—an opinion, the decision of which we leave to spectroscopists. Pickering, in Cambridge, U.S., has shown, from the absence of polarisation, that they do not shine with reflected light.

The last remarks remind us of the planets, that, no doubt, revolve round those distant suns, and derive from them their light and heat. When we reflect upon the complicated nature of the orbits, which the planets and comets describe round our sun, we get some idea of how remarkable must be the nature of those curves that planets describe round double suns, compared to which the motion of our moon is simple, and easily understood. Perhaps the same comets that disappear to our gaze, leaving the sphere of attraction of the sun, are attracted, and for a time become members of those wonderful systems. Our mathematics do not suffice for solving the problems that are thus suggested, but it is not unlikely that, unless situated very close to one or other of the suns—so close that the other appears not much larger than a star, though comparable in brightness to the nearest sun—the planets are whirled out in the cold space by the gravitational influence of the other sun, as very likely many a minor planet was ejected from the solar system under the influence of Jupiter. What must be the nature of those worlds illuminated by two different suns, one yellow and another purple? Now rises the one, and all is clothed in yellow, now the other, and illuminated from complementary sources, every object appears in its natural colour. Then sets the yellow sun, and what must be the diversity of the effects as it approaches the horizon! And behold nature puts on a purple mantle. Then also that sun sets, and in the darkness of night, though there is seldom night where there are two suns, the starry heavens are seen much the same there as here, except perhaps for moons reflecting light from the differently-coloured suns. But stars that seem large to us are hardly visible there, while our sun is perceived in the telescopes of the mysterious beings that inhabit those strange globes as only a faint star, and metaphysicians there prove from *a priori* considerations to their attentive pupils, that no life could bask in the feeble glare of a single sun—how all would famish but for the opposite effects of the two suns. And no doubt! life there is heightened, and the wonders of nature are unravelled by aid of and under the influence of the energy of several suns, more highly developed science, seeing how glorious is the creation on this poor orb, that is kept alive by but one. Not only the play of colour must there be more varied than here, but phenomena of which we have not the faintest idea, must be produced also through the action of heat, electricity, and magnetism.[1] Indeed, upon subjects like these, science gives no information, and we may therefore give our fancy free reins. Oh! that we did possess the power of appreciating these things like the divine Milton, when in truly prophetic strain he wrote:—

> "Other suns, perhaps,
> With their attendant moons, thou wilt descry,
> Communicating male and female light,
> Which two great sexes animate the world,
> Stored in each orb, perhaps, with some that live;
> For such vast room in nature unpossess'd,
> By living soul, desert and desolate,
> Only to shine, yet scarce to contribute
> Each orb a glimpse of light, conveyed so far
> Down to this habitable, which returns
> Light back to them, is obvious to dispute."

W. DOBERCK

---

[1] The tides upon the planets caused by the two suns must be very interesting. Of course they also produce tides upon each other, and their spots present no doubt most peculiar features. It is not unlikely that in some cases the phenomena presented by new as well as by some variable stars are to be explained as the effect of tides caused by darker companions.

ON THE PHOTOGRAPHIC SPECTRUM OF COMET (WELLS) I., 1882[1]

ON May 31 I obtained a photograph of the spectrum of this comet, with an exposure of one hour and a quarter. On the same plate I took a spectrum of α Ursæ majoris for comparison. The comet's spectrum on the plate consists of a strong continuous spectrum extending from about F to a little beyond H. I am not able to distinguish any of the Fraunhofer lines in this continuous spectrum. The slit was rather more open than was the case in photographing the spectrum of the comet of last year; this would make these lines less distinct, but the lines G and H are well seen in the star's spectrum taken under the same conditions. We may therefore conclude that the part of the comet's original light which gives a continuous spectrum is much stronger relatively to the reflected solar light in this comet, than was the case in the comet of last year, and for this reason the Fraunhofer lines are not distinguishable.

Observations of the visible spectrum had already shown that the comet differs remarkably from the hydrocarbon type common to all the comets, some twenty, which have appeared since spectrum analysis has been applied to these bodies.

The photographic spectrum shows, as was to be expected, that this essential difference of spectrum exists also in the more refrangible region. The very strong ultra-violet group assigned to cyanogen is not to be seen on the plate, and the bright groups between G and *h*, and between *h* and H do not appear to be present.

The head of the comet was in sharp focus upon the slit, and the continuous spectrum with defined edges corresponds to the nucleus which in this comet was very distinct. In this continuous spectrum at least five separate places of greater brightness are seen, which very probably represent groups of bright lines, though they are not sufficiently distinct in the photograph to admit of resolution. That this interpretation is correct, seems probable, from the circumstance that these groups, as shown in the diagram, project beyond the strong continuous spectrum on one side. This side corresponds to where the light of the coma, on the side of the nucleus next the sun, falls upon the slit. We learn, therefore, that the light of this part of the coma consists for the most part in this part of the spectrum of these groups, as here on the plate only an exceedingly faint continuous spectrum can be seen.

It is not possible to measure with any useful accuracy the beginnings and endings of the groups, as they are too faint at these points. Measures as accurate as the circumstances would permit have been taken of the brightest parts of the groups. The wave-lengths of these brightest parts are :

$$\left.\begin{array}{l}\lambda\ 4253\\ \lambda\ 4412\\ \lambda\ 4507\\ \lambda\ 4634\\ \lambda\ 4769\end{array}\right\}$$

In the visible spectrum the bright lines of sodium

---

[1] Substance of note read before the Royal Society, June 15, 1882.

appear to have been strong, and it may be that some of the light of some of the groups may be due to this substance.

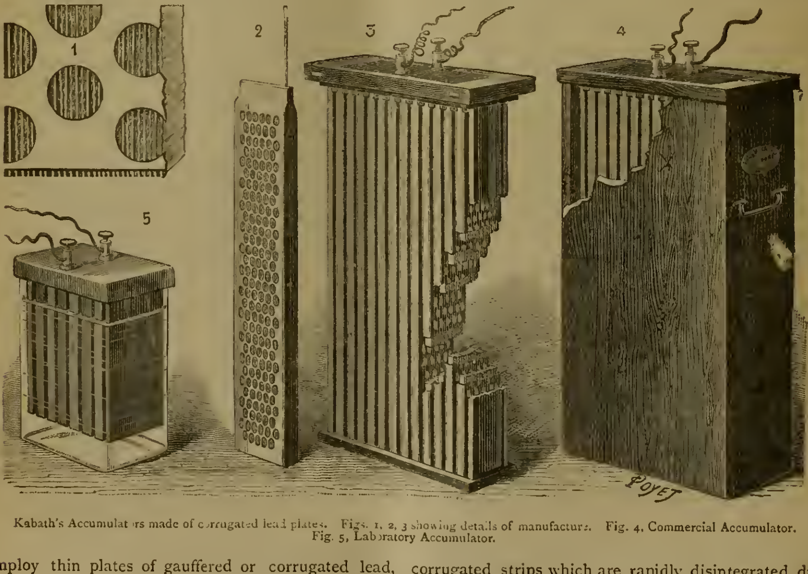
Prof. A. Herschel and Dr. von Konkoly showed long ago that the spectra of the periodic meteors are different for different swarms, and it does not seem surprising that we have now a comet, the matter of the nucleus of which under the sun's heat shows an essential chemical difference from the long series of hydrocarbon comets which have appeared since 1864.

Mr. Hind has kindly furnished me with the distance of this comet from the sun at the time the photograph was taken. The comet was then 42,380,000 miles distant from the sun, while the comet of last year was 69,420,000 miles when I obtained the photograph of its spectrum.

WILLIAM HUGGINS

KABATH'S ELECTRIC ACCUMULATORS

AT intervals since the introduction of accumulators or secondary batteries by M. Gaston Planté, various modifications have been made with a view to constructing cells on a commercial scale. The most renowned of these modifications was that of Faure, who applied red lead to the surface of the lead plates, so as to furnish a greater thickness of the spongy mass that is the effective agent in the storage process. In this development he had been anticipated by d'Arsonval, who sought to increase the efficacy of the oxidised lead electrode by covering it with a layer of lead dross. De Meritens, Tommasi, and others have worked in another direction by employing many sheets of lead foil presenting a large amount of surface, whilst Swan, Sillon, and Volckmar have taken another departure in applying perforated plates of lead with disintegrated material packed into the interstices. From our contemporary *La Nature* we have borrowed the accompanying illustration of another form of accumulator due to M. Nicolas de Kabath, whose suggestion is to employ thin plates of gauffered or corrugated lead, so as to secure a large amount of effective surface. The thin corrugated sheets are cut into narrow strips and packed between two stouter sheets of lead pierced with holes, through which the dilute acid liquor can circulate freely. The details of construction will be amply explained by the figures. The object of the perforated exterior is to prevent the cells from becoming short circuited by the possible falling down of the thin corrugated strips which are rapidly disintegrated during the preliminary charging or "formation" of the cell. The perforated leaden cases are themselves placed side by side in an appropriate cell, and are connected so that they serve alternately as positive and negative plates. Smaller cells are used for laboratory work. No details have yet been published, so far as we are aware, of their performances or capability of retaining the charge that has been imparted.



Kabath's Accumulators made of corrugated lead plates. Figs. 1, 2, 3 showing details of manufacture. Fig. 4, Commercial Accumulator. Fig. 5, Laboratory Accumulator.

SCIENTIFIC RESULTS OF THE ECLIPSE

THE following communication appeared in the *Daily News* of Tuesday from its special correspondent with the English Eclipse Expedition :—

In my last letter,[1] written as it seems, an age ago, for the incidents since the eclipse have been more or less emotional, I promised in a final one to give the opinions of the astronomers as to the bearing of the work they have been fortunate enough to do in Egypt this year upon the general question of solar inquiry. Hence we have to consider both results and methods, and the latter should include the questions which it seems now most desirable to put to the sun the next time he is eclipsed. First, then, as to results. There seems good ground for supposing that the outermost part of the sun's atmosphere suffers changes as does that lower portion in which sun-spots are observed, and that the changes synchronise. Now, in the case of spots, as is generally known, we have a maximum number every eleven years or thereabouts, and in the interval we have a minimum, during which no spots are seen for weeks together. Hence the so-called maximum sun-spot period and minimum sun-spot period. This supposition was first hazarded in 1878, a minimum sun-spot year, as a result of the comparisons of the observations of that year with those obtained in 1871, a maximum sun-spot year. In 1871 the corona was most extended away from the equator ; there was no special structure at the poles, and the hydrogen in it was strongly developed and it was very luminous. In 1878 it was most extended along the equator ; there was very special structure at both poles, the hydrogen had almost disappeared, and it was faint. Now in 1882, that is eleven years from 1871 and in another maximum sun-spot year, the corona has again put on its condition of eleven years ago. Hence observation has shown that the supposition is so far quite justified by the facts, and accepting this connection as a working hypothesis astronomers and physicists have now to try to connect the absence of spots in the lower atmosphere with a condition of things which gives us a great equatorial extension of the atmosphere, and very definite structure at the poles, associated in all probability with a lower temperature, or at all events a greater admixture of cooling material.

Before the Eclipse Expedition had left England Dr. Siemens had proposed a theory of the solar atmosphere which postulated exactly such conditions as appeared to be revealed in years of least solar activity. The coincidence between hypothesis and fact was, to say the least, extremely curious, and there is no doubt that the fact that when the sun is most active the correspondence seems to vanish, will have to be carefully considered. But we have learned more touching the outer atmosphere than its changes. There has been a chemical touch added. When in 1869 its chemical nature was first investigated by means of the spectroscope, it seemed to be built up almost entirely of a substance of which we knew nothing here—a substance revealed by a line in the green part of the spectrum, at 1474 of the scale employed by Kirchhoff for his maps, which were then generally in use. In 1870 hydrogen was added to this unknown substance, if we are to interpret spectroscopic phenomena in the usual manner ; and now again, with the same proviso, calcium has been added ; that is to say, some lines seen in the spectrum of calcium have now been detected in the spectrum of the sun's outer atmosphere. It is now some years since the strange behaviour of calcium when observed in the spectroscope was noticed, and it was the first substance used to point the moral that the spectra of terrestrial substances are sometimes strangely transformed when their lines are examined among those visible in the ordinary spectrum of the sun. Thus the widest lines of all in that spectrum—the lines lettered H and K for purposes of reference—are seen in the spectrum of calcium when high temperatures are employed, though they are absent at low temperatures, when, however, a line in the blue which is but feebly represented among the solar lines is thick and brilliant. The observations of the eclipse in Siam in 1875 strongly suggested that the so-called calcium was really an important constituent of the lower layers, while it is now known that it plays an important part in every spot and prominence ; indeed, in the spectra of sun-spots photographed by Mr. Lockyer at South Kensington, the H and K lines behave differently from all the other lines photographed. But the point of this year's work is that this calcium has been carried very high into the solar atmosphere, where it exists in such tremendous quantity that the eclipse colouring in all its weirdness can be traced to it, and the proof that this violet light is lighting up our atmosphere more powerfully than any other is found in the fact that in one of the photographs taken on Abney's plates the air between us and the dark moon is shown to be of this colour. This is photographic proof certain and sure, and will remind those learned in these matters of an observation made by Captain Maclear during the eclipse of 1870. It will be seen then that this year's work has left its marks both on the physics and chemistry of the outer atmosphere. We must now descend a little into the lower regions of the solar incandescent air.

Here we approach a very interesting part of the subject, but one on which it is difficult to say anything without going somewhat into detail. Up till a few years ago the idea that our terrestrial elements, such as iron, hydrogen, and the like, were anything but elements never entered the heads of astronomers as they were daily recording solar phenomena. It was obvious that the sun was very hot—so hot that it may be said the vapour of iron plays the same part there as the vapour of water plays here ; but the possible result of the high temperature remained practically unconsidered, and our notions of the structure of the solar atmosphere were influenced by terrestial chemistry. Hence, when it was found that the upper atmosphere consisted mainly of hydrogen, all the lines of the solar spectrum except those due to hydrogen were supposed to owe their origin to absorption of the solar light at very low levels, and close to the sun there was supposed to be a thin stratum, the work of which was so efficient in this direction that it was called the "reversing layer." But after a time, as facts were accumulated, the question whether our elements really could and did stand the temperature of the sun without breaking up into something more elementary still was fairly asked ; and as in other cases the question had to be discussed in a scientific manner—that is, cases had to be taken in which the question could be put to the facts in such a way that if the observations were of one kind one view would be strengthened ; if of another kind then the other explanation would be more likely the correct one. It was pointed out some time ago that there are two very definite kinds of observations which can be made during eclipses, by which much information might be gained bearing directly upon this question of dissociation—that is to say, the question whether our "elements," as we know them, are or are not capable of existing at solar temperatures. These observations had to do, one with the "reversing layer," the other with the outer atmosphere. The challenge was of the most direct kind touching the reversing layer It went so far as to say that the former observations had been erroneously interpreted. This, however, must not be held to cast doubt upon former observers. The contention was that the former work, dating from 1870, had been of too general a nature, and that when a small part of the field of observation was studied with minute accuracy it would be found that the general statement would be untenable, that general statement favouring the view that the elements are still truly

---

[1] Reprinted in NATURE, vol. xxvi. p. 129.

elementary at solar temperatures. It will be seen that the issue raised then could not be complained of as lacking crispness and definiteness. What then are the facts? The facts have been exactly as they were predicted on the rival hypothesis—the hypothesis, namely, that the elements are not elementary; and in future we are not likely to hear much more of the "reversing layer." The solar spectrum, indeed, appears now to be the result of the absorptive work of an innumerable number of strata one over the other, from top to bottom of the solar atmosphere. If we could see the work of any one of these layers by itself, it would be impossible for us, with our mere terrestrial laboratory experience, to recognise it, whereas we do recognise the sum total, because we get, and can only get as a rule, a sum total in our laboratory experiments. Should this result be generally accepted as one of the results of this year's work a great step will have been gained. Whether accepted or not, it is quite clear that such observations as those to which attention has been directed will demand much attention when next the sun is eclipsed. Nor is this all. It is not too much to hope now that M. Thollon has so admirably succeeded in furnishing astronomers with a spectroscope which combines the maximum of dispersion and light that observations suggested by the new view may be made on the uneclipsed sun and bring their tribute of precious facts every day the sun shines. Such work, indeed, was actually started at Sohag, and the test then afforded gave out no uncertain sound; but on this point it is not necessary to enlarge upon the present occasion, as both MM. Thollon and Trépied are pledged to utilise the beautiful climates of Nice and Algiers in carrying on this new survey at the earliest possible moment, and the world of science will doubtless soon hear something of the result of this new attack.

There is little doubt that on the occasion of future eclipses attention will be much more concentrated on the spectrum of the corona, and more specially-constructed instruments will be brought to bear on it than has been the case hitherto. We may already take for granted that the blue lines photographically recorded (in addition to H and K in the violet,) will have their position determined with the greatest accuracy, and their coincidence or not with marked Fraunhofer lines will have an important bearing upon the questions to which attention has been directed in the present letter. The work, too, has shown that the new plates are so sensitive that it will be quite easy at the next eclipse by means of a circular rotating plate, or some such contrivance, to record all the spectroscopic phenomena, however evanescent they may be, visible at the moment of disappearance or reappearance of the sun. Such a method will not only give us a complete history of what goes on, but will furnish us with a scale of exact reference. So science advances. Each effort, and especially the one most wisely planned, instead of exhausting the supply of new phenomena brings still newer efforts and richer harvests in its train.

I have been very unfaithful to the task imposed upon me if I have not convinced your readers that the expeditions whose work it was my duty to chronicle have been richly rewarded for their long preparations and tedious journeyings. They will all leave Egypt with the liveliest sense of gratitude for the manner in which all their efforts for the advancement of knowledge among men have been seconded by the Khedive and the Egyptian Government.

PROF. W. B. ROGERS

THE death is announced of Prof. William Barton Rogers, whose name is so well known in connection with the Massachusetts Institute of Technology at Boston, U.S. Prof. Rogers died suddenly, of apoplexy, while giving an address, on May 30 last, in connection with the Annual Graduating Exercises of the Institute. From the *Boston Daily Advertiser* we obtain some facts concerning Prof. Rogers' life and work:—

William Barton Rogers, the second son of four in a family noted for its scientific acquirements, was born in Philadelphia, in December, 1805. His father, Patrick Kerr Rogers, was a learned and enthusiastic lover of natural science, and is credited with being among the first in the United States to establish systematic courses of instruction in chemistry and experimental physics for the general public. Young Rogers was educated at William and Mary College, in which institution his father had been appointed Professor of Natural Philosophy and Chemistry. At the age of twenty-one he delivered, at the Maryland Institute, Baltimore, his first lectures on science, and one year later he succeeded to his father's position as professor at William and Mary College. In 1835 he accepted the appointment to the chair of natural philosophy in the University of Virginia, and there began instructing in mineralogy and geology. He remained there until 1835, and was next appointed to the chair of natural philosophy in the University of Virginia. There he added the subjects of mineralogy and geology to his course of instruction, and organised the geological survey of the State. He remained at the head of the Geological Survey until its discontinuance in 1842, and published annual reports, together with much valuable material which had been carefully collected. While at the University he published, for the use of the students, a short treatise on "The Strength of Materials," and a volume on "The Elements of Mechanical Philosophy." This period of his life was a very busy and attractive one, much of his time being given to original work in geology, and largely also in chemistry and physics. In the Association of American Geologists and Naturalists, organised in 1840, Prof. Rogers took a leading part. He contributed to its volume of *Transactions* many valuable memoirs, among them observations on the subterranean temperature in the coal mines of Eastern Virginia. In the exploration of the physical structure of the Appalachian chain, which formed the subject of one of the memoirs above alluded to, Prof. W. B. and H. D. Rogers were associated. Their generalisations were so novel and important in the estimation of European, as well as American geologists, as to give "the Gebrüder Rogers" a prominent place among their number. While a member of the Association of American Geologists he was elected several times its chairman. He presided at the meeting which expanded this last-mentioned Society into the American Association for the Advancement of Science, in 1847, and presided over the latter association at its meeting in Buffalo in 1876.

In 1853 Prof. Rogers removed to Boston, and at once identified himself with prominent educational interests here. With a committee of gentlemen no less interested than himself in the establishment in Boston of a school which should place the teachings of science upon a more practical plane than had hitherto been attempted, he drew up a scheme entitled "Object and Plan of an Institute of Technology," and embraced therein also a school of industrial science, a museum of arts, and a society of arts. To the accomplishment of this purpose he bent every energy, and at length a charter from the State was granted, providing the land upon which the institute buildings now stand. Subsequently the plans prepared by Prof. Rogers were almost completely carried out; and he, more perhaps than any other one man, brought about that admirable system of teaching which so characterises the institute, and which finds its place in the laboratories. His connection with the institute has been a most prominent one. He occupied the chair as president for many years, and at the start was at the head of the department of physics and geology. Since his removal to Boston, as well as before, Prof. Rogers has contributed largely to scientific journals in the United States and

Great Britain, and his articles embrace a very wide range of topics relating to the several departments of scientific research to which he had devoted himself, and many of his researches have attracted unusual attention from their value as adding to scientific knowledge.

At the age of seventy-six his failing health compelled him to give up active duties as president, and he resigned to give place to Mr. Francis A. Walker. He still continued to hold the position of professor *emeritus*, and retained it at the time of his death. His health has permitted him to continue at his duties, but he has not been strong, and the cause of his death, as above stated, is supposed to have been apoplexy. He was appointed by President Hayes as President of the National Academy of Sciences, and had returned from Washington only a few days before his death, where he had been presiding over a meeting of the academy.

The *New York Nation*, in reference to the death of Prof. Rogers, says:—

The death of Prof. Wm. B. Rogers, in Boston, on May 30, removes not only one of the foremost of our scientific men, but perhaps the one who had in the highest degree the faculty of presenting the claims of science on popular interest and respect with force and lucidity. He had a remarkable gift of expression, and an unusually winning and persuasive manner, both of which were supported by a character of the utmost purity and simplicity.

NOTES

THE Council of the Society of Arts have awarded the Albert Medal of the Society of the present year to Louis Pasteur, Member of the Institute of France, For. Memb. R.S., for "his researches in connection with fermentation, the preservation of wines, and the propagation of zymotic diseases in silk worms and domestic animals, whereby the arts of wine making, silk production, and agriculture, have been greatly benefited. The Council have awarded the Society's Silver Medals to the following readers of papers during the Session 1881-2:—To Prof. Silvanus Thompson, D.Sc., for his paper on "Storage of Electricity"; to J. Emerson Dowson, for his paper on "The Production and Use of Gas for Purposes of Heating and Motive Power"; to Col. G. F. Pearson, for his paper on "The Teaching of Forestry"; to Prof. Barff, M.A., for his paper on "A New Antiseptic Compound, and its Application to the Preservation of Food"; to Spencer Walpole, for his paper on "The Fish Supply of London"; to George F. Deacon, for his paper on "The Constant Supply and Waste of Water"; to Capt. Richard F. Burton, for his paper on "Gold on the Gold Coast"; to R. Warington, for his paper on "Some Practical Aspects of Recent Investigation in Nitrification"; to S. G. Thomas and Percy C. Gilchrist, for their paper on the "Manufacture of Steel from Phosphoric Pig-iron"; to Alexander M. Chance, for his paper on "The Recovery of Sulphur from Alkali Waste by Schaffner's Process, a record of recent results"; to James Mylne, for his paper on "Experiences of an European Zemindar (landholder) in Behar." Thanks were voted to the following Members of Council for the papers they had read:—To Capt. Douglas Galton, C.B., F.R.S., for his paper on "The American System of Heating Towns by Steam"; to W. H. Preece, F.R.S., for his paper on "Electric Lighting at the Paris Electrical Exhibition"; to Lieut.-Colonel C. E. Webber, R.E., for his paper on "Telephonic Communication"; to Sir Rutherford Alcock, K.C.B., for his paper on "The Opium Trade."

THE following has been forwarded to us from the Royal Society for publication:—

Florence, May 23, 1882

MY LORD,—An interesting commemoration in honour of Charles Darwin was held on Sunday last, the 21st instant, in the great hall of the Florence "Istituto di Studi Superiori." The commemoration was promoted by the Students in Medicine and Natural Science. The proceedings were simple, consisting of a few opening words by the Chairman of the Committee, Signor Fairman, a medical student, and a well turned and appreciative discourse by Prof. Mantegazza, whose scientific reputation is not confined to Italy. A bust of Darwin, in terra cotta, stood on the platform and marked the occasion. There were present the Prefect of Florence, the Council and Professors of the Institute, &c., while the large hall was crowded to overflowing with a mixed and attentive audience of ladies and gentlemen, showing the interest that the occasion had evoked.

I have, &c.,
(Signed) D. E. COLNAGHI,
H.M. Consul-General.

The Right Hon. Earl Granville, K.G., &c.

AN appreciative paper on Darwin, by the eminent naturalist, M. Alph. de Candolle, appears in the May number of *Archives des Sciences*. Darwin was prompt to acknowledge the work of his predecessors—Lamarck, Erasmus Darwin, and others—but seems with others to have overlooked the observations and ideas of Duchesne (1766), an evolutionist before Lamarck, to which M. de Candolle was able to call his attention while visiting him in 1880. Duchesne says: "The genealogical order is the only one that nature indicates, the only one that fully satisfies the mind; every other is arbitrary and vain (*vide d'idées*)." In the manner of exposition of facts and in reasoning, Charles Darwin (in M. de Candolle's opinion) rather resembles Duchesne than Lamarck or Erasmus Darwin. Lamarck is more systematic. Erasmus perceives much that he does not profoundly investigate; he is diffuse and lacks scientific method. Among other things. M. de Candolle remarks that nearly all *littérateurs* and men of science of the first rank have lived, during part of the year at least, in a town. One can hardly cite more than two exceptions (and they are very different), viz. Voltaire and Charles Darwin. The author gives an interesting picture of his visit to Darwin, who, as a septuagenarian, he says, "etait plus animé et paraissait plus heureux que je ne l'avais vu quarante-et-un ans auparavant, Il avait l'œil vif et une expression enjouée, tandis que ses photographies montrent plutôt sa conformation de tête d'un philosophe de l'antiquité. Sa conversation variée, franche, gracieuse, tout à fait d'un *gentleman*, me rappelait celle des savantes d'Oxford et de Cambridge." The author was struck with the sight of the domestic animals at Down, showing a "tranquillité qui suppose de bons maitres. . . . Vraiment, me disais-je, l'histoire des variations chez les animaux a été faite ici, et les observations doivent continuer, car Darwin n'est jamais inactif."

THE death is announced (though on doubtful authority) of Dr. Jules Crevaux, who has recently done so much for the exploration of French Guiana and the Amazon Valley. Dr. Crevaux, it is reported, has been assassinated, with his whole party, by Tobas Indians, while ascending the Pilcomayo River, on Argentine or Bolivian territory. He had started from Buenos Ayres, and had discovered near Salto the ruins of an ancient native city. The unfortunate explorer was only thirty-five years of age. He was a surgeon in the French Navy, and in July, 1877, undertook his first expedition into the interior of Guiana. Starting from Cayenne, he traversed an almost entirely unknown region, crossed the Tumuc-Humac Mountains, the water-shed between the Maroni and the Yari, a tributary of the Amazon. On a second journey in 1878-79, Crevaux went from Cayenne to the Oyapock, followed it up, and discovered the Kow, an unknown affluent of the Yari, followed the latter to its sources, and visited and explored to their sources the little-known affluents of the Amazon, the Paru, Iça, and Yapura. In 1880 he again set out, this time to the Magdalena and the

Orinoco, whose tributary, the Guyabero, he surveyed. A few months ago the indefatigable explorer started for Rio Janeiro for the purpose of exploring the country between that and the Middle and Upper Amazon, and in attempting to carry out this enterprise he, it is rumoured, has met with his untimely fate. We hope it will turn out to be without foundation.

THE death is announced of Mr. Alexander Leslie, whose name is associated with that of the distinguished Arctic explorer, Nordenskjöld. Mr. Leslie, who was a native of Aberdeenshire, was in his fifty-fourth year. He devoted much time to the study of practical farming, and acquired a considerable knowledge of agricultural [chemistry. Proceeding to Sweden, Mr. Leslie resided there for several years, and upon his return to this country he published, in 1879, through Messrs. Macmillan and Co., a narrative of the "Arctic Voyages of Adolf Eric Nordenskjöld, from 1858 to 1879." Our readers will remember that Mr. Leslie was the translator of the famous explorer's own account of "The Voyage of the *Vega* round Asia and Europe." Mr. Leslie was an occasional contributor to the columns of NATURE.

THE Danish steamer *Arcturus*, from Iceland, arrived at Leith on Saturday, and reported heavy casualties and serious loss of life during the recent storms. On May 13, Capt. Schonstrup met with immense ice-floes about fifty miles from the east coast of the island. He afterwards steamed to the south-west, west, and north coasts, but was unable, after leaving Reykjavik, to get near any of the ports for the ice. These coasts were again attempted on June 6, but with the same result, the fields of ice from Spitzbergen and the Polar seas being as extensive and impenetrable as before. Large districts are said to be suffering severely from famine, as the vessels are unable to land the provisions, on the customary arrival of which they depended. The severity of the weather is preventing the growth of the crops, and large numbers of sheep and ponies are dying. Measles, which have not been known in Iceland for the last thirty-five years, are very prevalent, and in Reykjavik alone no fewer than 200 persons were suffering from the epidemic when the steamer left.

DR. HJALTELIN, the distinguished physician of Iceland, so well known for the ready and hearty assistance he gave to all scientific explorers of the island, died suddenly at Reykjavik on June 5.

TORNADOES of unexceptional severity and destructiveness are reported from the Western States of America, particularly Iowa, Illinois, Missouri, and Kansas. One half of the town of Grinnel, Iowa, is stated to have been destroyed, and more than 100 persons killed, this tornado having swept over a tract twenty-five miles long and half a mile wide, with devastating energy.

THE seventh annual report of the Japanese Minister of Education states that there are 28,025 common schools in Japan of which 16,710 are public, and the remainder private; there being an increase of 1316 and 125 respectively, as compared with the previous year. The number of high schools is 107 public and 677 private, there being an increase of 42 and 63 respectively. Besides the above, many *Kindergarten* and primary schools were established. These private schools, even now, play a most important part in Japanese national life and education. Many of them have hundreds of students attracted by the fame of a single teacher. Youths flock from all parts of the country to sit at the feet of a renowned scholar, as men did in Europe to hear Abelard. The most celebrated of these leaders of youth—for this they are, rather than simple schoolmasters in our sense of the word—is Mr. Fukusawa of Tokio, whose translations from European books and original works on the political and social questions of the day, are read far and wide in Japan. The students of this gentleman fill many of the most important offices in the state; some of them recently formed themselves into a patriotic society, and established a newspaper, in which the acts of the government are subject to much caustic criticism. Long after the ordinary educational work of their teacher is done, and the young men have gone out into the world to do for themselves, they continue to reside near him, to study under his direction, and to form classes in which important public questions can be freely discussed under his guidance. One of his classes translated the whole of Adam Smith's "Wealth of Nations" into Japanese, with annotations, and many other important European works, especially those on philosophy and politics, owe their appearance in European dress to Mr. Fukusawa and his pupils. The school has been a real, and, we believe, a highly beneficial power in the state. These "private schools," which have been political associations, and debating clubs, as well as scholastic establishments, have occasionally played important parts at crises of Japanese history. The members of the private schools established in Kagoshima, the capital of Sakuma, originated and led the great rebellion of 1877. Fortunately Mr. Fukusawa's pupils are more peaceful in their objects and methods.

THE French Government has established a prize of 2000*l.*, to be given to the person who in the course of five years—from July 1, 1882, to July 1, 1887—will have invented the most useful application of the Volta pile. Foreigners are allowed to take part in this competition, which was instituted for the first time by Napoleon I., almost as soon as Volta invented his admirable instrument, and has been reopened at several periods.

THE proprietors of houses having a view of the Parc Monceaux have subscribed among themselves a sum for illuminating this garden with a number of Jablochkoff lights. Similar steps will be taken for other public gardens in Paris. The tradesmen located in the Palais Royal are establishing a private company for the same purpose. An experimental trial will be made within a few days with incandescent lights.

ON June 15 M. Marcel Deprez delivered, in the large hall of the Conservatoire des Arts et Métiers, Paris, a lecture on the transmission of electricity to great distances. The lecturer proved that magneto-electric machines could be moved by a current which had circulated through four kilometres of german-silver wire, whose resistance was twelve times longer than a similar wire of copper, and having a few millimetres diameter. M. Marcel Deprez declares that he will go almost to any length in diminishing indefinitely the diameter of the wire of his dynamo-magnetic machine, and that it is by resorting to large dynamos that he will be able to produce a current sufficiently powerful.

COL. LAUSSEDAT, director of the Conservatoire des Arts et Métiers, has placed at the disposition of aëronauts, a dynamometer of special construction for testing scientifically the resistance of their canvass before and after varnishing.

TWO German expeditions will go to American stations in order to observe the transit of Venus in December next. Observations will be taken at Stratford, Connecticut; at Aiken, South Carolina; at Bahia Blanca; and at Punta Arenas.

MR. GILDER, one of the correspondents of the *New York Herald* in Siberia, telegraphs from the Lena Delta, April 24, that he has found the bodies of Capt. De Long and his companions, who, it may be remembered, were in the missing boat belonging to the *Jeannette*. The poor men had evidently perished of cold and hunger.

DR. HASSELBERG of Pulkova has been able to trace the bright line of sodium seen by many observers in the spectrum of Comet Wells, to some distance in the tail of the comet.

THE Merchant Venturers' Company of Bristol have resolved to erect, at an expense of 30,000*l.*, a new Technical School on the site of the old Bristol Grammar School, for the use of the

Bristol Trade and Mining School, founded by the exertions of the late Canon Moseley, in 1855.

A RECENT report by Dr. Bürkner to the Göttingen Royal Society of Sciences, on his "Polyklinik" for ear disorders, gives some instructive facts. In 1881 the number of patients was 516 persons (338 male and 178 female), with 583 different forms of ear disorder. The doctor reckons that a cure was effected in 61·85 per cent. of the patients, and improvement in 15·12 per cent. 211 (or 40·9 per cent) of the patients were of juvenile age, 15 and under. There were 139 cases of injury of the external ear, 15 of the tympanum; 322 of the middle ear, 27 of the inner ear, and 13 sundry. For otorrhœa, pulverised boric acid was largely used. The greatly praised iodoform was fully tried in ear-treatment, but Dr. Bürkner considers it has "no future" in this sense. Leiter's heat-regulator, consisting of very flexible lead tubes, through which water of any desired temperature is conveyed to injured parts of the body, did good service, especially in inflammation.

FOR the Sanitary Institute Congress at Newcastle-upon-Tyne, September 26, the following gentlemen have accepted the presidentship of the various sections:—Dennis Embleton, M.D., F.R.C.P., Section I. Sanitary Science and Preventive Medicine; Henry Law, M.I.C.E., Section II. Engineering and Sanitary Construction; Arthur Mitchell, M.A., M.D., LL.D., F.R.S., Section III. Meteorology and Geology.

MR. W. G. INNES, of Great St. Helens, has sent us a few specimens of photographs of New Zealand scenery, taken by Burton Brothers, of Dunedin. They are beautiful specimens of the photographic art, and many of them are of interest from a geological and ethnological point of view. One photograph gives an excellent idea of the White Terrace at the Rotomahana Hot Springs, others show some of the grand mountains and beautiful bays, native life, &c.

MR. BRYCE WRIGHT has, we understand, received a very fine specimen of the interesting gem known as Alexandrite, from India.

THE enormous glacier, Fon or Svartisen (69° 25′ N., 35° 15′ E.) on the Senjen Island in Norway, and which is the northernmost of its kind in Europe, will shortly be made the object of a remarkable enterprise. It appears that a number of speculative merchants in Bergen have obtained the right of cutting block-ice for export from its surface. Some blocks have already arrived at the latter place, and as the quality of the ice has been found to be good, large shipments may be expected. The glacier is about 120 square miles, and as the distance from its border to the sea is only a couple of miles, the ice may be obtained very cheaply. A similar attempt to utilise the glacier Folgefonden was made some years ago, but failed, owing to the blocks in their downward course repeatedly breaking through the wooden bore or conductor in which they were slid down to the sea.

THE Zoological Museum of the Lund University has just received as a gift from Prof. Nordenskjöld a splendid specimen of the sea-cow, *Rhytina Stelleri*, now extinct, brought by the *Vega* from Behring Island.

PASTEUR's discoveries having been doubted in Germany, they have been submitted to the appreciation of a special commission in Berlin, and M. Pasteur sent thereto one of his assistants to perform vaccination on sheep. The report has been sent to Paris, and is said to approve the process and to show that it has been quite as efficient in Germany as in France.

THE *Daily News* correspondent at Maritzburg reports that a brilliant comet has been observed there for the last two or three days, in close proximity to the sun.

WE have on our table the following books:—China, by Prof. R. K. Douglas (S.P.C.K.); White's Manual of Naval Architecture, 2nd edition (John Murray); Electric Lighting, by Th. du Moncel, translated by R. Routledge (George Routledge and Sons); La Bourboule, by Dr. G. H. Brandt (H. K. Lewis); the Funeral Tent of an Egyptian Queen, by Villiers Stuart (John Murray); Hot Water Heating, by F. A. Fawkes (Batsford); Notes on Cage Birds, edited by W. T. Green (Upcott Gill); Botanical Atlas, Part II., by Dr. M'Alpine (W. and A. K. Johnstone); Im Fernen Osten, 2 vols, by Gustave Kreitner (A. Hölder); Results of Rain and River Observations made in New South Wales during 1881, H. C. Russell, Sydney; Handbook of Invertebrate Zoology, by W. K. Brooks (Cassino, Boston, U.S.); How to Overcome the Potato Disease, by J. S. Jensen (Menzies); A Synopsis of Elementary Results in Pure and Applied Mathematics, vol. i., section 9, by G. S. Carr (Hodgson and Son).

THE additions to the Zoological Society's Gardens during the past week include an Arabian Baboon (*Cynocephalus hamadryas* ♂) from Abyssinia, presented by the Messrs. James; a Bonnet Monkey (*Macacus radiatus* ♂) from India, presented by Master G. H. Clark; a Chima-chima Milvago (*Milvago chimachima*) from Demerara, presented by Mr. G. H. Hawtayne; two Upland Geese (*Bernicla magellanica* ♂ ♀), five Ruddy-headed Geese (*Bernicla rubidiceps*), a Loggerheaded Duck (*Tachyeres cinereus*) from the Falkland Islands, presented by Mr. F. E. Cobb, C.M.Z.S.; a Rufous-necked Weaver Bird (*Hyphantornis textor*) from West Africa, a Common Lapwing (*Vaneltus cristatus*), European, presented by Mr. J. S. Baldwin, F.Z.S.; a Loggerhead Turtle (*Thelassochelys casuana*) from the Straits of Bonifacio, presented by Lord Lilford, F.Z.S.; a White-backed Piping Crow (*Gymnorhina leuconota*) from Australia, deposited; a Black-fronted Antelope (*Cephalophus nigrifrons*) from Africa, a Water Chevroain (*Hyomoschus aquaticus*) from West Africa, three Darwin's Rheas (*Rhea darwinii*) from Patagonia, two Spanish Blue Magpies (*Cyanopolius cookii*) from Spain, purchased; an Egyptian Goose (*Chenalopex ægyptiaca*), a Chiloe Wigeon (*Mareca chiloensis*), five Mandarin Ducks (*Aix galericulata*), bred in the Gardens. The following insects have emerged during the past week:—Silk Moths: *Actias selene*, *Samia cecropia*; Moths: *Sphinx pinastri*, *Deiliphila euphorbiæ*, *Trochilium apiformis*, *Sciapteron tabaniformis*, *Sesia conopiformis*, *Sesia museæiformis*, *Hypochera io*, *Callimorpha dominula*; Butterflies: *Vanessa xanthomelas*, *Vanessa urticæ*, *Aporia crabægi*.

OUR ASTRONOMICAL COLUMN

THE APPROACHING TRANSIT OF VENUS.—In deducing the following expressions for determining the times of contacts in the transit of Venus on December 6, for any point upon the earth's surface, the positions of the planet have been taken from Hill's Tables, which had an advantage over Leverrier's at the last transit, and Auwer's semi-diameter is adopted. For the sun the semidiameter deduced by Leverrier from the transits of Mercury has been employed.

For *first external* contact, there results—

Dec. 6, 1h. 56m. 12s. $+[2{\cdot}5442]\, r \sin l$
$-[2{\cdot}4793]\, r \cos l \cos (L - 87^\circ\ 35'{\cdot}0)$.

For *first internal* contact—

Dec. 6, 2h. 16m. 52s. $+[2{\cdot}5822]\, r \sin l$
$-[2{\cdot}4768]\, r \cos l \cos (L - 85^\circ\ 31'{\cdot}9)$.

For *last internal* contact—

Dec 6, 7h. 54m. 0s. $-[2{\cdot}2894]\, r \sin l$
$+[2{\cdot}6261]\, r \cos l \cos (L - 138^\circ\ 18'{\cdot}8)$.

For *last external* contact—

Dec. 6, 8h. 14m. 41s. $-[2{\cdot}2152]\, r \sin l$
$+[2{\cdot}6142]\, r \cos l \cos (L - 134^\circ\ 38'{\cdot}1)$

The angles from N. point for *direct* image are respectively 145°·1, 148°·4, 116°·9, and 113°·5.

In the above formula r is the radius of the earth at the place, l the geocentric latitude, and L the longitude from Greenwich, reckoned *positive* towards the *east*. The resulting times are

Greenwich mean times. The quantities within square brackets are logarithms of seconds of time.

THE CORDOBA OBSERVATION OF COMET 1881 II., ON JUNE 11.—In NATURE, vol. xxv. p. 519, we gave an account of Dr. Gould's observations of the great comet of last year, on the evening of June 11, when he compared it with an object which he could not identify as a fixed star, and it was mentioned that Mr. Tebbutt had suggested that the objects really observed were not the comet and a star, but the two stars λ Eridani and Bradley 718, which have almost precisely the differences of right ascension and declination that were recorded on the night in question. This explanation we considered a probable one, and the same view was taken by the editor of the *Astronomische Nachrichten*, which has occasioned a further communication on the subject from Dr. Gould, who rejects Mr. Tebbutt's suggested solution of the difficulty.

Dr. Gould says the appearance of the comet on June 11 precluded the slightest doubt as to its identity. "The tail itself could not be seen with the telescope, it is true, but the large, diffuse, and very elongated head, much brighter and more definite on the advancing side, was sufficient to enable the veriest tyro to recognise it as a comet." He was placed necessarily on the top of a high observing chair, which he did not leave during the observations, the records being made by his assistant. He had made several sweeps to find a suitable comparison-star, and was about to commence a new one, when he saw the object referred to above, "at the upper part of the field on the left, while the comet was on the right, below." The four published comparisons were then made, and whilst he was in the act of pointing the micrometer-thread upon the comet for a fifth, it disappeared below the horizon. He adds, that no jar of the instrument had taken place; "the field of the telescope was fully under control from the beginning, the declination-clamp remaining tight throughout," and he insists that no one who saw the comet could have entertained the idea that any amount of blurring could have given such an aspect to a fixed star, though it were far brighter than λ Eridani. And he doubts whether a star of the sixth magnitude would have been visible under the circumstances. He made experiments on subsequent evenings, by looking at known stars of different magnitudes when close to the horizon and through different degrees of haze, but in no case did he find one offer the appearance noted on June 11. Hence, he proceeds: "I can only suppose another comet to have been in the field. That it was not a companion-comet is manifest, not only from the relative motion, and from an examination made the next day, but still more from the abundant scrutiny in the northern hemisphere, which could not have failed to detect any companion. That it was not a fixed star, was evident from the beginning."

Thus the matter is left by Dr. Gould, who, it must be admitted, is by far the most competent judge of the probable explanation of the difficulty.

MASKELYNE'S SOLAR PARALLAX.—By communications from Mr. J. Morris, Hatfield Hall, Durham, and Mr. B. J. Hopkins, Marlborough Road, Dalston, we learn that the value of the solar parallax given by Maskelyne, to which allusion was made in this column last week, appears in the third edition of Vince's "Elements of Astronomy," Cambridge, 1810: it was therefore published during his life-time.

THE ROYAL SOCIETY OF CANADA

THIS Society, which has been founded under the auspices of the Marquis of Lorne, and is intended to be to Canada what the Royal Society and the Institute are to England and France respectively, held its first meeting on May 25, 26, and 27. Inaugural addresses were delivered on the 25th by the Marquis, Principal Dawson, and the Hon. P. J. O. Chauveau. For the purpose of reading and discussing papers, the Society is divided into four sections:—(1) French literature, history, and allied subjects; (2) English literature, history, and allied subjects; (3) mathematical, physical, and chemical sciences; (4) geological and biological sciences. The following papers were read in Section 3:—Note on zinc sulphide, by T. McFarlane. On the "transition" resistance to the electric current at the bounding surface between amalgamated zinc and solutions of zinc sulphate, by Prof. J. G. MacGregor, D.Sc. The "transition" resistance in this case was shown to be at any rate not greater than a small fraction of an ohm, the current being weak and the electrodes large. The method of measurement employed was a modification of that formerly used by Beetz.—On the measurement of the resistance of electrolytes by means of Wheatstone's bridge, by the same. In this paper, a new mode of using the bridge was described. Alternate currents were sent through the bridge, and brought into the same direction by a commutator in the galvanometer branch, in which one of Thomson's galvanoscopes was inserted. Two of the arms contained equal metallic resistances; the other two contained, besides metallic resistances, electrolytic cells the same in all respects, except as to length. Thus the errors due to polarisation and possible "transition" resistance were eliminated.—On molecular contraction in natural sulphides, by Prof. E. J. Chapman.—On the law of facility of error in the sum of n independent quantities, each accurate to the nearest unit, by Chas. Carpmael, M.A. The chance of the error in the sum lying between y_1 and y_2, where $y_2 - y_1$ is small, was shown to be

$$\frac{1}{\lfloor\underline{n-1}}\left\{\left(\frac{n}{2}+y_1\right)^{n-1} - n\left(\frac{n}{2}+y_1-1\right)^{n-1} + \frac{n\,.\,\overline{n-1}}{1\,.\,2}\left(\frac{n}{2}+y_1-2\right)^{n-1} - \&c.\right\}(y_2-y_1),$$

the series to be continued as long as the part raised to power $n-1$ is positive. This series is approximately equal to

$$\sqrt{\frac{6}{\pi n}}\,.\,e^{-\frac{6y^2}{n}}\,(y_2-y_1).$$

—A symmetrical investigation of the curvature of surfaces; including a discussion of the plane sections of quadrics, the axes of conic sections and of quadrics, by Prof. A. Johnson, LL.D. In this paper it was shown that the leading theorems concerning principal radii of curvature, directions of principal sections, umbilics, lines of curvature, &c., can be obtained directly by a purely analytical investigation, elementary and symmetrical in its character, of the plane sections of a quadric.—Note on the deduction of the equation of continuity, by Prof. Loudon.—Note on the motion of a chain on a fixed curve, by Prof. Cherriman.—Note on the application of a remarkable determinant, by the same.—Note on a question of probabilities, by the same.—On the general regulation of civil time, by Sandford Fleming, C.E.—On the utility of geometry as applied to the arts and sciences, by Chas. Baillarge.

The following papers were read in Section 4:—The distribution of some saline and other plants in the West, by Prof. Maconn. This was an oral exposition, aided by a large map of certain peculiarities in the distribution of maritime Eastern and Western plants in the interior of the continent, and of some peculiar extensions of Southern plants to localities far north of their usual range.—Note on a general section from the Laurentian axis to the Rocky Mountains, north of the 49th parallel, by Dr. G. M. Dawson. This paper gave a summary of the latest facts respecting the succession and distribution of Cretaceous and early Tertiary beds in the North-West Territories, and of the facts obtained respecting their subdivision into groups, and the useful deposits of coal and lignite contained in them.—On the cretaceous and tertiary floras of British Columbia and the North-west territory, by Dr. J. W. Dawson, F.R.S., &c. The researches of the Geological Survey have resulted in the collection of series of fossil plants from a number of localities in the cretaceous of the Pacific coast, and of the eastern base of the Rocky Mountains, in the laramie or lignitic group of the plains, and in the Tertiary Lake Basins of British Columbia. From these it appears that while up to the Middle Cretaceous a flora of strictly Mesozoic character, consisting of pines, cycads, and ferns prevails, the Middle and Upper Cretaceous show the introduction of a larger number of broad-leaved evergreens of modern types. Though there seems to be a continuous prevalence of warm and temperate conditions, from the Upper Cretaceous, up to the Pliocene, the groups of plants observed may be classed as—(1) Lower and Middle Cretaceous; (2) Middle and Upper Cretaceous, with modern evergreens, as *Salix*, *Populus*, *Magnolia*, *Betula*, *Quercus*, &c., and fan palms and cycads; (3) Laramie or Fort Tunis group, probably a transition from the Cretaceous to the Eocene, with many new forms; (4) Tertiary Flora of the probably Miocene Tertiary of British Columbia. Descriptions and figures of these plants are being prepared, and it is hoped may soon be published.—On the anatomy and development of cestoid worms, by Prof. Ramsay

Wright.—On lacustrine concretions from Grand Lake, N.S., by Prof. Honeyman, D.C L.—Illustrations of the fauna of the St. John, N.B. group, by G. F. Matthew.—On birds from Hudson's Bay, by Prof. Bell.—On a new classification of Crinoids, by Prof. E. J. Chapman. This classification is based essentially on the presence or absence of a canaliculated structure in the calyx and arm plates. Three leading divisions are thus recognised. In one, the plates are without internal canals; in the second, the arm plates are perforated internally; and in the third, a system of canals radiates from the base of the calyx to the extremities of the arms. The subdivisions have been worked out to bring readily under grasp the more salient or broadly distinctive features of all the better-known families and types; and as the common names of families embody very little indication of these features, an additional grouping into sections is adopted.—On the Lower Cretaceous rocks of British Columbia, by J. F. Whiteaves.—On the introduction and dissemination of some noxious insects, by Wm. Saunders.—On the geological history of the St. John (N.B.) river valley, by Prof. L. W. Bailly.—On recent discoveries in the life-history of *Botrydium granulatum*, a terrestrial Canadian alga, as illustrating phases of development in the lower forms of vegetation, by Prof. G. Lawson, Ph.D., LL.D.—On the Quebec group of rocks, by Dr. A. R. C. Selwyn.

The following officers were elected: President, J. W. Dawson, C.M.G., LL.D., F.R.S., Principal of McGill College, Montreal; Vice-President, Hon. P. J. O. Chauveau, LL.D.; Hon. Secretary, J. G. Bourinat, F.S.S., Ottawa; Hon. Treasurer, J. A. Grant, M.D., Ottawa.

ON SMELL

THE sense of smell is caused by the contact of certain substances with the terminal organs of the olfactory nerves, which are spread as a network over a mucous membrane lining the upper part of the nasal cavity. Each nerve consists of a number of small bundles, themselves capable of being split into extremely fine nerve fibres. There are spindle-shaped cells connected with these nerves, from which proceed two processes—one to the surface, provided with bundles of long hairlets; the other passes to the interior. It is these hairlets which are proprobably the proximate cause of smell.

Let us consider, first, by what are smells excited? The operation of smelling is performed by sniffing, that is, by a series of short inhalations of air, bearing with it the odorous body. The first question which suggests itself is: Is the substance which excites sensation a liquid, solid, or gas? It has been tried by Weber, to fill the nose with eau-de-Cologne and water, lying on the back for that purpose, and pouring the liquid into the nostrils by a funnel. No sensation is produced. I have myself tried the experiment, and can confirm his observation. There is an irritating feeling, but no smell. Of course, on washing out the nose, or blowing it, the characteristic smell is at once noticeable.

It is easy to prove that solid particles are not the cause of smell. If the air conveying the odour be filtered through a tube filled with cotton wool, and inserted into the nose, a smell is still discernible, although all solid particles must thereby be kept back. But it is a very remarkable circumstance that it is so, for one would not suspect such extremely non-volatile substances as copper, iron, silver, &c., to give off gas, if indeed the smell which they most certainly evolve when rubbed is due to the gas of the substance.

We must, therefore, conclude that the sense of smell is excited by gases only. It is of course necessary to include under the name gases the vapours of liquids or solids which have low vapour-tension, and which, in consequence, give off vapour at the ordinary temperature. It has been proved that this is the case even with mercury, the boiling point of which is over 300° Centigrade. We may consequently conclude that many other substances of which it is impossible to measure the vapour-tension at ordinary temperatures, owing to its extreme minuteness, also evolve gas, if only in very small quantities. But it is well known that all gases have not the power of exciting a sense of smell. Let us compare some gases which have smell, with some which have none, and endeavour to discover if those which have smell have any other property in common.

The following is a list of gases which have no smell:—Hydrogen, oxygen, nitrogen, water-gas, marsh-gas, olefiant-gas, carbon monoxide, hydrochloric acid, formic acid vapour, nitrous oxide, and ammonia. Those which possess smell are chlorine, bromine, iodine; the compounds of the first two with oxygen and water, the second three oxides of nitrogen (or perhaps it is right to say nitric peroxide, for the other lower oxides are changed into it when they come into contact with air); the vapours of phosphorus and sulphur; arsenic and antimony; sulphurous acid, carbonic acid, and almost all the volatile compounds of carbon, save those already mentioned; some compounds of selenium and tellurium; the compounds of chlorine, bromine, and iodine, with the above-named elements; and some metals.

In considering this list, I submit first, that the property of smell is peculiar to some elements and their compounds. Thus, chlorine, bromine, iodine, sulphur, selenium, and tellurium, which are volatile or give off vapour at ordinary temperatures, have a characteristic smell. We should expect their compounds to have a smell, and we find this to be the case. Second, those substances which have no smell, or produce simple irritation of the nostrils have all low molecular weight. Such is the case with hydrogen, the element of lowest specific gravity. Such also is the case with oxygen and nitrogen; but this as well as the absence of smell in water-vapour, may be ascribed to the constant presence of these gases in our atmosphere, and their necessary constant presence in our nostrils, so that we may be insensible to their smells because we are always inhaling them; but I think it probable that this is not so. Hydrochloric, hydrobromic, and hydriodic acids, and ammonia, have purely an irritating effect, and cannot be described as smells. When ammonia is pure and free from compounds containing carbon, it has no trace of smell. Nitrous oxide is also the lowest of the oxides of nitrogen, and as such has the lowest specific gravity. But it is when we turn to compounds of carbon that we are best able to draw general conclusions; for that element, *par excellence*, has the faculty of forming almost innumerable compounds, and series which resemble each other in properties, but differ in specific gravity. And here we are most struck with the fact that increase of molecular weight, *i.e.* increase of specific gravity in the form of gas, produces, to a certain point, smell. Let us examine the simplest series, viz. the marsh-gas or methane series, commonly called the paraffins. The first two of these have no smell. Ethane, indeed, which is fifteen times as heavy as hydrogen, begins to have a faint trace, but it is not till we arrive at butane, which is thirty times heavier than hydrogen, that a distinct sensation of smell is noticed. In the same manner, the olefine series, of which the first member is ethene, or olefiant gas, gains in smell with rise of molecular weight. Of course, the highest members of this series have no smell, for they are non-volatile, but this is the case with most carbon compounds of which the molecular weight is high.

A similar relation is noticeable among the alcohols. Methyl alcohol, in a state of purity, is smell-less; ethyl, or ordinary alcohol, when freed from ethers and as much as possible from water, has a faint smell, and the odour rapidly becomes marked as we rise in series, till the limit of volatility is reached, and we arrive at solids with such a low vapour tension that they give off no appreciable amount of vapour at the ordinary temperature. Again, with the acids, formic acid is smell-less, and produces a pure sensation of irritation. Acetic acid has a slight but characteristic smell; and the higher acids of the series, propionic butyric, valerianic acid, &c., gain in odour with increase in density in the form of gas. If we consider the nitrogenous compounds of carbon, we are led to the same conclusion. Prussic acid is not smelt by more than four persons out of every five; but the nitriles, which bear the same relation to prussic acid as the higher members of a series bear to the lower, have all very characteristic odours. Acetylene would appear to form an exception to this rule; but carefully purified acetylene has little odour, and it is surpassed by its higher homologues. We may therefore, I think, accept this as a principle—that the intensity of the smell rises with rise in molecular weight.

It is also noticeable that the *character* of a smell is a property of the element or group which enters into the body, producing the smell, and tends to make it generic. Thus we can characterise the compounds of chlorine and its oxides as chlorous; indeed we may group the three elements—chlorine, bromine, and iodine, together, and name the characteristic odour of them and their oxides haloid smells. Similarly, sulphur, selenium, and tellurium, in their compounds with hydrogen, have a generic smell; and likewise arsenic and antimony. The only oxide of nitrogen which is smelt is nitric peroxide, so that it is impossible to pronounce on a generic smell for this substance. It is, again, easier to classify carbon compounds. The smell of the paraffins is generic; so is that of the alcohols, the acids, the nitriles, the amines with their irritation like that of ammonia, the bases of the pyridine series, the hydrocarbons of the benzene group, the higher hydrocarbons, such as naphthalene, anthracene, and phenanthrene. Give any one of these to a chemist familiar with the smell of any one of each series, and accustomed to use his sense of smell, and he will at once refer the body to its class.

The tendency of a rise in the series is to make the smell "heavier," less ethereal, and more characteristic. It also becomes more able to affect the olfactory nerves.

The rate at which smell travels is doubtless the rate at which the vapour which gives rise to it diffuses. Still it is impossible to test this experimentally. For the ease with which a smell is perceived varies with the molecular weight of the substance. Thus, if a piece of cotton wool be impreguated with ethyl alcohol, and placed in one end of a long tube, which is immediately corked, and a similar arrangement be adopted with amyl-alcohol, the fifth of the series of which the former is the second; although their specific gravities have the ratio of 23 to 44, and the ethyl-alcohol should diffuse $1\frac{2}{5}$ times as rapidly as amyl-alcohol, yet the smell of the latter will be perceived first, because a much smaller quantity produces the sensation.

It is possible, with practice, to make a fairly accurate analysis by means of the sense of smell. The method is, knowing the constituents of a mixture, to prepare one which has the same smell, measuring the proportions of the ingredients. The only precaution to be observed is that the smell of no member of the mixture be so overpowering as to mask those of the others. Thus I have analysed, or rather synthesised, a mixture of chloroform with ether, alcohol with ether, and these liquids with carbon disulphide, provided the latter be pure, to within 2 per cent.; but I failed with members of the pyridine series. Yet it was possible to detect the proportions of members of that series to each other; and it is not difficult, however extraordinary it may appear, to guess approximately the boiling-point of a mixture of members of a series, after some practice, purely by its smell.

So far as I know, no theory has been brought forward to account for the sense of smell; and I therefore venture to supply this want, premising that what follows is merely a tentative explanation, and as such will, I hope, not be too severely criticised.

There is a probability that our sense of smell is excited by vibrations of a lower period than those which give rise to the sense of light or heat. These vibrations are conveyed by gaseous molecules to the surface network of nerves in the nasal cavity. The difference of smells is caused by the rate and by the nature of such vibrations, just as difference in tone of musical sounds depends on the rate and on the nature of the vibration, the nature being influenced by the number and pitch of the harmonies.

Let us see what evidence can be adduced for the theory. Among the lightest substances which have smell are sulphuretted hydrogen and phosphoretted hydrogen, both of which are seventeen times as heavy as hydrogen itself. Prussic acid is fifteen times as heavy as hydrogen, and has a smell. But all persons are not able to perceive it. I have remarked an average of one in every five persons who are totally unable to detect its odour. Here we reach the lowest limit of molecular weight. *To produce the sensation of smell, then, a substance must have a molecular weight at least fifteen times that of hydrogen.* If we compare the hydrocarbons of the paraffin series, with each other, and similarly the olefine series, we notice that the lower members have no smell. The specific gravity of marsh-gas, CH_4, is 8; that of ethane, C_2H_6, 15; propane, C_3H_8, is twenty-two times as heavy as hydrogen, and here we first notice smell. Olefiant gas, C_2H_4, has the specific gravity 14, and has no smell; propene, C_3H_6, has a faint smell with a specific gravity of 21; and the higher members of the series increase in intensity of smell with increase in specific gravity. Hydrocyanic acid is smelt by most persons, but not by all. Its specific gravity is 15. The higher members of the series, called the nitriles, have all very characteristic smell. Formic acid vapour has the specific gravity 23, and has a purely pungent odour. Acetic acid, 30 times as heavy as hydrogen, has a faint smell when pure; opionic, butyric, and valerianic acids have strong smells. Methyl alcohol has no smell; its specific gravity is 16; ethyl alcohol, 23 times heavier than hydrogen, has a faint smell; and, as usual, the intensity, and if I may so term it, the flavour of the smell, increases as we rise in series.

These are the most typical instances of the carbon compounds, and they suffice, I think, to show the justice of the assertion that the intensity of smell increases with rise of molecular weight. The hypothesis of vibration satisfactorily explains this. The period of vibration of the lighter molecules is too rapid to affect our sense; there is a limit to this power; and just as some people have the power of hearing more acute sounds than others, so some senses are limited by a specific gravity of 15, and cannot smell prussic acid. Such people also have difficulty in perceiving the odours of bodies of slightly higher molecular weight than prussic acid.

Let us now inquire what is the probable rate of such vibrations. Mr. Johnston Stoney and Prof. Emerson Reynolds have made investigations of the ratio of the bright lines of some spectra, and have calculated their relations to each other. An analogy will make the nature of this relation more evident. When a note, say C, below the treble clef is sounded on a piano, not only the tone C is heard, but its octave C on the third space; also G above the line, C on the third leger line, E on the fourth, G on the sixth, B flat above the G, and other notes. These are called harmonics, or over-tones. Now if we knew these over-tones, it would be possible to refer them to their fundamental. So with light. The light evolved by incandescent gases consists of certain colours, which have each their own rate of vibration. Knowing these rates it is possible to calculate the rate of vibration of the fundamental. This has been done by Mr. Stoney (Royal Irish Academy, January 9, 1871) with hydrogen, with the following results.—

Wave-lengths, *h*, 4102·37 tenth-seconds
,, F. 4862·11 ,,
,, C, 6563·93 ,,

These are the 32nd, 27th, and 20th harmonics of a fundamental whose wave-length is 0·1313 millimeters. The time of vibration is 4·4 fourteenth-seconds. It may be objected that these coincidences are not a proof. But Mr. Stoney and Prof Reynolds have measured the lines of the spectrum of chromyl chloride, and its 31 lines coincide with those calculated. The probability of the correctness of such a calculation approaches to almost absolute certainty. Now we have no means of recognising such fundamental vibrations, unless, indeed, the sense of smell is one means of receiving them. And it is this which appears to me probable; so probable, indeed, as to form a working theory.

But it is to radiant heat, I think, that we must look for indications of harmonics of the fundamental vibrations which are, according to this theory, the cause of smell. And a fresh proof may be drawn from the indications already seen. Prof. Tyndall has shown the power which odours have of absorbing heat-rays. There is no doubt that by refracting such heat-rays by means of a rock-salt prism, after they have passed through an atmosphere of odour, certain portions of the heat-spectrum show colder spaces, each corresponding to the particular rate of vibration which is absorbed by the vapour, through which the heat-rays have passed. By measuring the position of such gaps in the heat-spectrum, calculating the particular rate of vibration of the rays at such gaps, and referring them to their fundamental, we should arrive at the rate of vibration of the molecule which causes smell.

We may now inquire what it is which produces quality of smell. This, I think, can also be explained by the vibration theory, and depends on the harmonics of the vibration. Thus, the quality of tone of a violin differs from that of a flute by the different harmonics or overtones, peculiar to each instrument. I would ascribe to harmonics the quality of smell possessed by different substances. And it is to this that compounds of chlorine, phosphorus, &c., owe their peculiarity of odour. The odour of compounds resembles that of these elements to some extent; this may be accounted for by the similarity of overtones of compounds and their elements. Then we notice a similarity in quality of the odour of a compound of a series like the alcohols, and yet the quality grows flatter and heavier with increase in molecular weight.

Smell, then, may resemble sound in having its quality influenced by harmonics. And just as a piccolo has the same quality as a flute, although some of its harmonics are so high as to be beyond the range of the ear, so smells owe their quality to harmonics, which, if occurring alone, would be beyond the sense. It must be remembered that the harmonics are not heard separately from the fundamental, unless special means be adopted to render them audible, but they add their vibrations to those of the fundamental.

When two sounds are heard simultaneously, they give a concord, or a discord, but each may be separately distinguished by the ear. Two colours, on the other hand, produce a single impression on the eye, and it is doubtful whether we can analyse them. But smell resembles sound and not light in this particular. For in a mixture of smells, it is possible, by practice, to distinguish each ingredient, and as I have shown, to match the sensation by a mixture.

With regard to the mechanism by which smell is conveyed to the nerve, all that can be said is pure speculation. But as it is supposed that the vibrations of sound are conveyed to the auditory nerve through the small cirrhi, or hairs which spring out of round cylindrical nerve-cells in the superficial layer of connective tissue of the epithelium of the internal ear, and that each is attuned to some particular note of vibrations, so it may be imagined that the hair-like processes connected with the spindle-shaped cells, themselves communicating with the nerve-fibres of the olfactory nerve, are the recipients of the vibrations causing smell. Although the rate of such vibrations is extremely rapid, no less indeed in the case of hydrogen than 4,400,000,000,000,000, or the four quadrillions, four trillionth part of a second, yet the wave-length is by no means so small, for it averages the 2-100th of an inch, a magnitude quite visible with the naked eye. And hydrogen has no smell; those bodies which have smell, and higher molecular weight, must necessarily have a slower period of vibration, and possibly greater wave-length.

It is doubtful whether there exists a lower limit to our sense of smell. The vapours of osmic acid, carbon tetrabromide, selenium, tellurium, and arsenicous and antimonious oxides are among the heaviest known, and they have a most distinct smell. There appears to be a limit in practice, however, owing to the non-volatility of substances of high molecular weight at such temperatures at which smell may be perceived. The intense perfume of flowers is to be ascribed to the terpenes, of which common turpentine is one, or to their products of oxidation, and these bodies all possess a molecular weight of 136, and the specific gravity 68, a specific gravity which appears to excite the olfactory nerve most powerfully.

I bring forward the theory adduced with great diffidence. The problem is to be solved, in my opinion, by a careful measurement of the "lines" in the spectrum of heat-rays, and the calculation of the fundamentals, which this theory supposes to be the cause of smell. Such measurements and calculations, even if they proved the theory untenable, would have great value for their own sake, and labour expended in this direction would not be lost. Whether successful or not, it would at least be a first assault on what old John Bunyan called "Nose-gate of the City of Mansoul." WILLIAM RAMSAY

University College, Bristol

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—A syndicate, on which Dr. Ferrers, Prof. Stokes, Prof. Balfour, Mr. Todhunter and Mr. Trotter may be taken to represent the interests of science, has been appointed to frame regulations for the new degrees of Doctor of Science and of Letters. Candidates for these degrees are required by the new statutes to have made some original contribution to the advancement of science or of learning.

In the last Mathematical Tripos under the old regulations (January, 1882) the full marks were 27,150, and the average marks of the first ten wranglers were 6712, of the last ten 2890; first ten senior optimes average 2093; first ten junior optimes, 818. Out of 1407 marks given to the problems in the first three days, the first ten wranglers gained an average of 255; out of 8161 given to the problems in the last five days, the same ten averaged 849.

An important report by Mr. G. H. Darwin, who was the additional examiner in the same tripos, criticises severely the style in which the work of many men was done. Not a few sent up answers in atrocious handwriting, and omitted to define many symbols employed. The subjects which exhibited the average weakness of grasp most flagrantly was thermodynamics. A great many men had read something of it, but very few really understood what they attempted to explain. "Extraordinary muddle and confusion" was sent up in answer to a question on the absolute scale of temperature. On another question, while the very elements of the subject were unknown to those who answered, the same men reproduced faultlessly the algebraical calculation of the thermodynamic function for a perfect gas. Mr. Darwin strongly recommends such changes in the style of questions as that half intelligence may be more stringently treated, and men induced to read less and master more, and to gain a comprehension of physical principles.

The affiliation of University College, Nottingham, to Cambridge University has been formally recommended, so soon as the constitution of its governing body has been altered so as to admit a representative of the University. Scientific subjects have full recognition in the college course of study, by which exemption from one year's residence at Cambridge may be obtained, provided the student takes a degree in honours.

When Statute B comes into operation, the present Board of Natural Science Studies is to be replaced by two Boards—that of Physical and Chemical Studies and that of Biological and Geological Studies. These Boards will include, besides the Professors and Readers belonging to these studies, the Tripos Examiners of two years in the respective subjects belonging to the Boards, and three members of the Senate elected to serve for three years.

The second part of the Natural Sciences Tripos this year has no name in the first class, a result probably attributable to the transition state of the Tripos. Next June a better result may be anticipated, unless students with one consent let alone the more advanced parts of all the subjects. If this is the consequence of the recent changes, it will be much to be regretted.

OXFORD.—The term that has just ended has been chiefly remarkable for the fact that the new Statutes have come into operation in default of obstruction in Parliament. Already at several of the colleges, tutors and lecturers who have vacated their fellowships by marriage, have been re-elected "official Fellows;" and others who hold fellowships under the old ordinances have transferred themselves to the new official class.

But little legislation has been effected in Convocation: the only proposal of the Hebdomadal Council which provoked opposition was that to raise the University dues from five shillings to seven and sixpence a term, and to double the fee for Responsions (smalls), making it 2*l.* instead of 1*l.* Both proposals were carried on a division. The new Statute on Private Halls—containing provisions for bringing the master and students of such halls under the direct supervision of the University—was passed after being amended in Congregation. A Statute postponing the date of the University Examinations was also passed; so that in future the final honour schools will not commence before the last week of term.

During Michaelmas term, there will be offered two scholarships for proficiency in Natural Science. At Balliol there will be an election to a scholarship on the foundation of Miss Hannah Brakenbury, "for the encouragement of the study of Natural Science," worth 80*l.* a year (55*l.* and tuition free), tenable during residence for four years: open to all such candidates as shall not have exceeded eight terms from matriculation. This examination will begin on Thursday, November 16, at ten o'clock. Papers will be set in the following subjects:—(1) Mechanical Philosophy and Physics; (2) Chemistry; (3) Biology. But candidates will not be expected to offer themselves in more than two of these. There will be a Practical Examination in one or more of the above subjects, if the Examiners think it expedient. There will also be an optional paper in Mathematics; and the literary qualifications of the candidates will be tested by an English essay, or by a paper of general questions.

At Trinity College one Millard and Combe Scholarship, of the annual value of 80*l.*, without limit of age, will be awarded in October next for proficiency in Natural Science if any Candidate of sufficient merit offers himself. The Scholarship is tenable in the first instance for two years, and will be prolonged for two years more, if the President and Fellows are satisfied with the industry and good conduct of the scholar. For special reasons it may be prolonged for a fifth year. The subjects of examination will be Chemistry and Physics. Candidates may also offer Mathematics, if they wish to do so and give notice a week before the examination. Special weight will be attached to excellence in one or two subjects, rather than to a less thorough knowledge of all. Candidates will also have an opportunity of doing one Classical paper. The scholar elected will not necessarily be required to commence residence immediately. The President will receive the names of candidates and their testimonials of character on Tuesday, October 10, between 8 and 9 p.m. The examination will commence on Wednesday, October 11, at 9 a.m.

SCIENTIFIC SERIALS

Proceedings of the American Philosophical Society, vol. xix. No. 109, June to December, 1881.—Continuation of notes on an Egyptian element in the names of the Hebrew kings, &c., by S. P. Lesley.—Notes on the geology of West Virginia, by J. C. White.—Bhotodynamic notes, III. and IV., by P. E. Chase.—On Alaskaite, a new member from the series of bismuth sulphosalts, by G. A. König.—The auriferous gravels of North Carolina, by H. M. Chance.—On some mammalia of the lowest eocene beds of New Mexico, by E. D. Cope.—Notes on the Quinnemont coal group in Mercer Co. of West Virginia and Tazewell co. of Virginia, by J. J. Stevenson.—Notes on the coal-field near Cañon City, Colorado, by the same.—The brain of the cat (*Felis domestica*); I., Preliminary account of the gross anatomy, by B. G. Wilder.—Exploration of the River Bene with the hitherto unexplored regions of Bolivia, by E. R. Heath.—The names of the Gods in the Kiche myths, Central America, by D. G. Brenton.

The Transactions of the Academy of Sciences of St. Louis, vol. iv. No. 2, 1882.—The hieroglyphic tablet of Pompeium grammatically translated and commented on, by E. Seyffurth.—Notes on North American *Microgasters*, with descriptions of new species, by C. V. Riley.—Descriptions of some new *Tortricidæ* (leaf-rollers), by the same.—On certain problems in refraction, by F. E. Nipher.—Magnetic determinations in Missouri during the summer of 1880, by the same.—"Reversion of type" in the digastric muscle of the human being, by C. A. Todd.—Ephemeris of the satellites of Mars for the opposition of 1881, by H. S. Pritchett.—The genus *Isoetes* in North America, by E. Engelman.—Auroral phenomenon, September 12, 1881, by E. A. Engler.

Revue d'Anthropologie, Paris. Deuxieme, Fascicule (1882), contains:—A paper by Dr. Paul Broca—left incomplete at his death—on so-called Ectromelian monstrosities, or those in whom there is an abnormality, but not an absence, of certain parts of the body.—Contributions to the study of muscular variations in human races, by Théophile Chudzinski. This paper is one of a series, the earlier parts of which appeared in the *Revue* for 1873-1874, and which will be continued in subsequent numbers.—On the cephalometric square, and its mode of application, by Dr. Topinard, who also describes the respective merits and demerits of the methods usually employed by artists to determine the facial angle and its relation to other parts of the body.—On the populations of the peninsula of the Balkans, by the late French geographer and traveller, Guillaume Lejean, sometime vice-consul at Khartoum, and at Massaouah. This portion of the author's exhaustive history of the origin and settlements of all the various peoples who have occupied the Hemus peninsula since it was held by the ancient Thracians, ends with the complete subjection, in the thirteenth century of the Slaves by Latin princes holding lands under the Greek Empire.—In a paper entitled "Les Griots," Dr. Berenger-Feraud describes those itinerant musicians who are to be met with in every part of Central Africa, from the shores of the Atlantic to the Indian Ocean, and who, notwithstanding the low castes to which they belong, constitute a distinct confederation under the authority of a chief, who exercises great authority over its scattered members, and levies a heavy tax for his own use from their general receipts. These people, whose name of Griots is a French corruption of the Onolove word "Gwewonal," are regarded with fear and repugnance by the negro natives of the lands which they traverse, and where they are looked upon as members of an impure caste, whose dead are capable of bringing sterility and perpetual drought to the ground in which they are buried. They are skilled in improvising and reciting; and while some play the violin and guitar, the least gifted among them beat the tam-tam or play on various discordant wind-instruments. The confederation is undoubtedly of long-standing, and while the Griots, who perpetuate many ancient myths and songs, contribute towards the maintenance of some degree of intercommunication among the African races, they are credited with fomenting frequent dissensions, by trafficking with the information which they acquire through the extraordinary license granted them of going where they will among rich and poor, both in times of war and peace.—A critical review of all that is known of the Chukches, or Yu-its, by M. J. Deniker, gives the substance of what has been learnt of the ethnological and social standing of these Arctic peoples from the narratives of Nordqvist, Nordenskjöld, the Russian Argoustinovitch, Krause, Dall, and others.

Mathematische und Naturwissenschaftliche Mittheilungen, &c. (Berlin Academy), Heft 1, 1882.—Report of work in connection with the Humboldt foundation for natural research and travel, by E. Du Bois Reymond.—The thermo-dynamics of chemical processes, by H. Helmholtz.—On abnormal forms of pine-cones, by A. W. Eichler.—On the molecular refraction of liquid organic compounds, by H. Landolt.—The embryonal excretory apparatus of the gill-less *Hylodes martinicensis*, by E. Selenka.—On the differences of phase of electric vibrations, by A. Oberbeck.—On twisted rock-crystals, by E. Reusch.—On geognostic observations by G. Schweinfurth in the desert between Cairo and Suez, by E. Beyrich.—Investigation of volcanic rocks from the region of Abu-Zabel, on the Ismailia Canal, by E. Arzruni.—On the terminal growth of phanerogam roots, by S. Schwendener.—On an abundant exhalation of sulphuretted hydrogen in the Bay of Mesolungi, by G. Von Rath.—On transformations of amide by action of bromine in presence of alkalies, by A. W. Hofmann.—On the phosphates of thallium and lithium, by C. Rammelsberg.—The present state of science, by E. du Bois-Reymond.—On the production of amides of mono-basic acids of the aliphatic series, by A. W. Hofmann.—On the production of mustard-oils, by the same.—Crystallographic researches on sublimated titanite and amphibole, by A. Arzruni.—Congratulatory addresses to Von Bischoff and to Henle on attaining their doctor-jubilee.

THE last number of the *Journal* of the Russian Chemical and Physical Society (vol. xiv. fasc. 5) contains several valuable papers. Prof. Mendeleeff contributes an interesting paper "on the heat of combustion of hydrocarbons," and a note on his experiments on the resistancce opposed by water to the motion of solid bodies.—Prof. Butleroff contributes a notice on the important question as to the variability of atomic weights, and another on the oxidation of isodibutylene by permanganate of potassium; and M. Woeikof discusses the influence of local topographical conditions of meteorological stations on the average temperatures of winter.—Besides, we notice papers on the formation of hypochlorites and chlorates during the decomposition of chlorides by means of a current, by MM. Lyadoff and Tikhomiroff.—On the separation of barium from strontium and calcium by means of chromates, by M. Meschersky.—On the structure of nitrated products of the fat series, by M. Kisel.—On the critical state of bodies, by M. Stoletoff.—On the electrical conductibility of vacuum, by M. Kraewitscb.—On vibratory telephonic signals, by M. Jacoby.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 15.—"On a Deep Sea Electrical Thermometer." By C. William Siemens, D.C.L., F.R.S.

In the Bakerian Lecture for 1871, delivered before the Royal Society (*Proc. Roy. Soc.*, vol. 19, p. 443), I showed that the principle of the variation of the electrical resistance of a conductor with the temperature might be applied to the construction of a thermometer, which would be of use in cases where a mercurial thermometer is not available.

The instrument I described has since been largely used as a pyrometer for determining the temperatures of hot blasts and smelting furnaces, and Prof. A. Weinhold (*Annalen der Physik und Chemie*, 1873, p. 225), using the instrument with a differential voltameter described in my paper referred to, found its indications to agree very closely with those of an air thermometer within the limits of his experiments from 100° to 1000° C. I am not aware, however, that any results have been published of its application to measuring temperatures where a much greater degree of accuracy is required, as in the case of deep sea observations. My friend, Prof. Agassiz, of Cambridge, U.S., ordered last year, for the American Government, an instrument designed by me for this purpose, and during the autumn it was subjected to a series of tests on board the United States Coast and Geodetic Survey steamer *Blake*, by Commander Bartlett.

The apparatus consists essentially of a coil of silk-covered iron wire ·15 millim. diameter, and about 432 ohms resistance, attached to an insulated cable by which it can be lowered to the required depth, and connected so as to form one arm of a Wheatstone's bridge. The corresponding arm of the bridge is formed by a second coil made precisely similar to the former one and of equal resistance. This coil is immersed in a copper vessel filled with water, and the temperature of the water is adjusted by adding iced or hot water until the bridge is balanced. The temperature of the water in the vessel is then read by a mercurial thermometer, and this will also be the temperature of the resistance coil.

To avoid the error, which would be otherwise introduced by the leads of the resistance coil, the cable was constructed of a double core of insulated copper wire, protected by twisted galvanised steel wire. One of the copper cores was connected to each arm of the bridge, and the steel wire served as the return earth connection for both.

Sir W. Thomson's marine galvanometer with a mirror and scale was employed to determine the balance of the bridge.

Mr. J. E. Hilgard, assistant in charge of the United States Coast and Geodetic Survey, has sent me the results of Commander Bartlett's experiments. The apparatus was set up on board the *Blake* in April, 1881, and experiments were made off the east coast during August. In each series of experiments the temperatures at different depths were first taken by Miller-Casella thermometers attached to a sounding wire. A sinker was then fastened to the resistance coil, and it was lowered by the cable to the same depths, and the temperature read by means of the mercurial thermometer attached to the comparison coil. The depths at which readings were taken ranged from the surface down to 800 fathoms, and experiments were made both in rough and still water. The temperatures recorded varied from 38·5° to 81·5° F. In every case the readings of the electrical instrument were precisely the same as those of the Miller-Casella thermometers for the surface and the maximum depth; but for intermediate positions it was observed that the electrical thermometer in almost every case gave a slightly higher reading. This discrepancy may be accounted for, I think, by the circumstance that the electrical thermometer gives the temperature of the water actually surrounding the coil at the moment of observation, whereas the Miller-Casella instrument brings to the surface, or at least its readings are effected by, the maximum or minimum temperatures encountered in its ascent or descent, which may not coincide with that at the point of stoppage. This furnishes a very strong argument in favour of the superior accuracy of the electrical instrument.

It was found that about five minutes must be allowed at each observation for the resistance coil to assume the temperature of the water surrounding it, and a second period of five minutes for adjusting the temperature of the comparison coil on deck. Allowing five minutes more for lowering the cable, fifteen minutes sufficed to complete a deep sea observation.

Chemical Society, June 1.—Dr. Gilbert, president, in the chair.—The following papers were read:—Determination of nitric acid in soils, by R. Warington. The sample should be taken in dry weather from the subsoil, as well as from the surface. It is dried at 55° C., and powdered. About 200 to 500 grms. are extracted in a vacuum filter with about 100 c.c. of water; the extraction requires ten to forty-five minutes. The nitric acid is determined by a modification of Schlœssing's method, the nitric oxide gas obtained being measured.—On a spectroscopic study of chlorophyll, by Dr. Russell and Mr. Lapraick. The anthors have not endeavoured to isolate a pure substance, but have endeavoured to follow spectroscopically the changes of a body (or bodies) which gives a particular absorption spectrum. This chlorophyll was extracted by a mixture of alcohol and ether, and gives the well-known absorption spectrum of four bands easily seen, and three other bands in the violet end, which are not noticed with gaslight. This chlorophyll, by treatment either with a small quantity of almost any acid, or with some salts, as ferric chloride, mercuric chloride, &c., or by heat, is changed, and gives another characteristic spectrum, to which the authors gave the laboratory name of "half-acid" chlorophyll; by the action of strong hydrochloric acid, a further change is produced, and an absorption spectrum is obtained, which is named "acid" chlorophyll. Alkalies act on chlorophyll, and give eventually an absorption spectrum of one broad band in the red. Very concentrated caustic potash solution splits this band into two bands, one of which ultimately disappears. The eye observations and measurements were checked with photographs taken by Capt. Abney. All leaves gave similar results, except some acid leaves, from the vine, &c., which gave half-acid chlorophyll instead of the normal product, when extracted with alcohol and ether.

Zoological Society, June 6.—Prof. W. H. Flower, F.R.S., president, in the chair.—The Secretary called the attention of the meeting to the curious way in which the young Cormorants lately hatched in the Gardens were fed by the parent birds, and exhibited a drawing by Mrs. Hugh Blackburn illustrating this subject.—A communication was read from Prof. St. George Mivart, F.R.S., containing a series of observations on certain points in the anatomy of the Cat-tribe (*Æluroidea*).—Mr. Howard Saunders read a paper on some *Laridæ* collected by Capt. H. H. Markham, R.N., on the coasts of Peru and Chili; comprising, amongst other rarities, the third known example of the large Fork-tailed Gull (*Xema furcatum*), a species which had been vainly sought for on the Pacific coast of America for upwards of thirty years. The author drew attention to the peculiarities distinguishing the various species of gulls found in the Pacific from those of the rest of the globe, and pointed out that, owing to oceanic currents, the connection between the species now only found on opposite sides of the equator had evidently been much more recent in the Pacific than in the Atlantic.—Prof. F. Jeffrey Bell read a paper containing an attempt to apply a method of formulation to the species of the *Comatulidæ*, and added the description of a new species, which he proposed to call *Actinometra annulata*.—Mr. Francis Day, F.Z.S., read some notes on the supposed identity of a specimen of a fish determined by Dr. Günther as *Anguilla kieneri* with a Gadoid *Lycodes*.—Mr. E. J. Miers read the second portion of his paper on the crustaceans received by the British Museum from the Mauritius, and called special attention to what appeared to be a variety of *Palinurus longimanus* of the West Indies which occurred in it.—Mr. W. A. Forbes read the fifth of his series of papers on the anatomy of Passerine birds. The present communication was devoted to the consideration of the structure of the genus *Orthonyx*, which was shown to be a true Oscinine form.—Mr. H. J. Elwes exhibited and made remarks on a Stonechat (*Saxicola*) which he had obtained during a recent expedition to the Aures Mountains of Algeria.—The Secretary exhibited a series of the diurnal and nocturnal lepidopterous insects bred in the Insect House in the Gardens during the present season.

Royal Horticultural Society, May 23.—Sir J. D. Hooker in the chair.—*Foliage injured by salt in the late gale*:—Dr. Church described experiments he had made at Cirencester during the last fifteen years to ascertain the amount of salt in the rain brought by autumnal gales, especially from the south-west. He found from 5 to 7 grs. per gallon, while the ordinary amount was only ·5 grs. The average winter amount was but slightly in excess of the average summer quantity. He noticed that in Oakley Park, one side of the trees was severely injured, and that, if no rain followed for a few days after the gale, the salt sparkled on the trees, even at a distance of thirty-five miles from the sea. The salt abstracted the moisture from the leaf-cells, and formed a condensed solution, so that the leaf became completely dried up, and perished. Mr. McLachlan added that salt had been observed on windows at Lewisham, as at Croydon, and elsewhere. Sir J. D. Hooker remarked that Dalton was the first to record a similar observation at the beginning of this century. With regard to beeches withstanding the gale better than oaks, as mentioned at the last meeting, it was elicited that they were unhurt at Kew, and Valewood, Haslemere, but at Cirencester, in Dorsetshire, and Cornwall, they suffered severely. Mr. Blackmoor exhibited foliage of pears, &c., from Teddington, some of which was quite unhurt; of other trees growing adjacent to them, the leaves were much injured. Vines and peaches showed similar differences. He suggested that it could not be salt in this case. The opinion generally entertained was that such discrimination were due to the trees being of relatively hardy and less hardy kinds.—*Rhododendron triflorum*: Mr. Mangles exhibited sprays of this species from the Himalayas. It belongs to the scaly-leafed section, and he observed that members of this group will not hybridise with any species of rhododendron without scales on the foliage.—*Malformed tulip*: Mr. Smee exhibited a tulip having petals distributed down the peduncle, a not uncommon occurrence. Mr. Henslow remarked on the fact that when such a petal was half-green and half-coloured, the tendency of the latter half is to check the growth and elongation of the peduncle. This causes the latter to bend over towards the side on which the petal is attached, and often so much so that it cracks on the opposite side, and may even decapitate itself.—*Change of sex in Rhododendrons:* The Rev. G. Henslow showed a flower in which the corolla was doubled, the stamens partially petaloid, while the pistil was open below with stamens, a tuft of imperfect petals and stamens arising from the base. He showed a drawing of a somewhat similar condition made in 1875, in which the style had become strap-shaped, was partially coloured red, and bore anther-cells on the margins; the pollen, however, was evidently abortive.

Entomological Society, June 7.—Mr. H. T. Stainton, F.R.S., president, in the chair.—Mr. P. B. Mason exhibited dark varieties of *Zygæna filipendulæ*, and *Callimorpha dominula*, as well as of the insect formerly supposed to be *Agrotis helvetina*, Boisd., but which was now believed to be a remarkable variety of *Noctua augur*.—The President remarked that there had been a great mortality this spring among the young larvæ of the currant saw-fly (*Nematus ribesii*).—Mr. McLachlan read a revised list of British *Trichoptera*.—Mr. W. L. Distant read descriptions of new species and a new genus of *Cicadidæ* from Madagascar.—Mr. A. G. Butler communicated descriptions of heterocerous *Lepidoptera* collected in Chili by Mr. Edmonds: *Geometrites*.

Victoria (Philosophical) Institute, June 15.—Annual meeting; the Right Hon. the Earl of Shaftesbury, K.G., in the chair.—Prior to the delivery of an address on the scientific aspects of the last Palestine survey, by Mr. Trelawney Saunders—who gave a careful analysis of the valuable results of the survey of Palestine, especially noticing the accord of the results with the Bible narrative—the honorary secretary, Captain F. Petrie, read the report, from which it appeared that the total number of members was now upwards of 950, Prof. Pasteur and many other well-known men of science having joined the Society in the past year.

Paris

Academy of Sciences, June 12.—M. Jamin in the chair.—The death of M. Conalia, Correspondent in Rural Economy, was commented upon.—On a point of the mathematical theory of effects in the game of billiards, by M. Resal.—Characters and *rôle* of double salts formed by fusion, by MM. Berthelot and Ilosvay.—Remarks on the use of zinc-carbon couples in electrolysis, by M. Berthelot.—Note on some explosive alloys of zinc and platinum-metals, by MM. Deville and Debray. Osmium is the only one of the platinum metals which does not retain zinc when one treats its alloy having a large excess of zinc, with an acid capable of dissolving this metal. The action of zinc on osmium-iridium is explained, according to laws of thermo-chemistry. (The heat liberated in union of zinc with iridium is enormous, and greatly exceeds that in union of osmium and iridium).—M. de Lesseps reported on the Suez Canal, and gave an account of the s.s. *Austral*.—M. Schlœsing was elected Member in Rural Economy in room of the late M. Decaisne.—Programme of astronomical work to be done by the scientific expedition sent to the south pole, by M. Lœwy. Classing the observations as (1) accidental, and (2) regular, those of the transit alone belong to the first; the second class include determination of the hour, the latitude and the longitude; of the radiant points of the southern heavens; and search for comets.—Observation of the Venus transit at Cape Horn, by M. Mouchez. The Transit Committee reluctantly gave up the island of Cape Horn for the mouth of the River Santa Cruz in Patagonia (for the most southerly station), the chances of good weather being so small; but they urge the importance of providing the Cape Horn scientific mission with instruments for transit observations.—Instructions for the naturalists of the Cape Horn Mission, for investigation of the animals on Terra del Fuego and adjacent islands, by M. Blanchard. *Inter alia*, the small mammals, as unable to cross wide arms of the sea, should throw light on questions in physical geography. Do the land birds migrate to the continent in winter? Are there batrachians in those parts? &c. Special means must be taken in those cold and wet climates for discovery of insects, few species of which attract notice by number or bright hues.—Instructions for the mission to Cape Horn, by M. Duchartre. In botany, special regard should be given to marine algæ.—Geological instructions, by MM. Daubrée and Des Cloizeaux. Search for fossil *débris* and for earthy meteorites and masses of native iron is urged; also investigation of raised beaches.—Programme of meteorological and magnetic observations, by M. Angot. Direct observations to be made at 4 and 8 a.m. and p.m. at midday and at midnight, (the expedition has a complete series of registering apparatus, and for certain instruments, a double series). *Inter alia*, full instructions are given for observation of austral auroras.—Observations of planets 221, 222, 223, 224, and of Comet *a* 1882 (Wells) at Paris Observatory, by M. Bigourdan.—Observations of the same comet with the 7-inch meridian circle at Bordeaux Observatory, by M. Rayet.—Ditto with the 6-inch Brunner equatorial at Lyons, by M. Gonessiat.—On a mode of transformation of figures in space, by M. Venecek.—On the law according to which the electromotive force of a magneto-electric machine varies in function of the resistance of the exterior circuit, by M. Deprez. The diminution of electromotive force in the ring, when the current becomes very intense, is due to insufficiency of the inductors. The wires of the ring cut the magnetic lines of force at an angle increasingly different from a right angle (at which maximum force is had).—Oscillations of the plane of polarisation by the discharge of a battery; simultaneity of electrical and optical phenomena, by MM. Bichat and Blondlot. A Leyden jar was discharged through a coil round a transparent body (*e.g.* flint) between polariser and analyser, and each time there was reappearance of the extinguished light. In one arrangement the image of a slit in the polariser was viewed in a rotating mirror, with a telescope, at each discharge; and one saw a series of bright bands (as in the case of a spark). The plane of polarisation was proved to oscillate about its normal position.—Decomposition of salts by matters in fusion, by M. Ditte.—Action of heat on an acid solution of sulphate of nickel in presence of sulphuretted hydrogen, by M. Baubigny.—On the mechanism of putrid fermentation, and on the alkaloids resulting from it, by MM. Gautier and Etard.—On the decomposing action of certain organic matters on oxygenated water; *à propos* of a memoir by MM. Bert and Regnard, by M. Béchamp.—On the aptitude communicated to cold-blooded animals to contract charbon by raising their temperature, by M. Gibier. Charbon was communicated to frogs (five out of twenty) compelled to live, after inoculation, in water at 35° to 37°. The bacteria developed were longer than usual (due to slow circulation).—Does the mechanism of absorption of virus vary with the nature of the wounds? Does the nature of the wounds affect the efficiency of surgical intervention? by M. Rodet. The nature of the wound affects only the rapidity of the propagation, not at all the mechanism of absorption; the penetration is, in by far the most cases, by the lymphatic vessels, very rarely by the blood-vessels exclusively, and seldom, comparatively, by blood-vessels and lymphatics.—On the sub-basaltic alluvions of the Corions (Ardèche), by M. Torcapel.—Probable lowering of the current water in the valley of the Seine during the summer and autumn of 1882, by MM. Lemoine and de Préandeau.—M. Carré described a new fire-alarm; an iron wire, constantly stretched by a spring, and closing a circuit (with bell) when elongated by heat; communication is made by rupture, as well as by expansion of the wire.

CONTENTS

THURSDAY, JUNE 29, 1882

THE FUNERAL TENT OF AN EGYPTIAN QUEEN

The Funeral Tent of an Egyptian Queen. By Villiers Stuart, of Dromana, M.P. (London: John Murray, 1882.)

THE startling discoveries of the royal mummies in the pit of the Deir-el-Bahari has already been the subject of great interest, and cast an unexpected light on the history of embalming and the vicissitudes of the dead as well as the living, revealing the unexpected transport of the monarchs from their costly chambers and sarcophagi of the Biban-el-Molouk to the Deir-el-Bahari in the fifth year of a monarch named Herhor, of the 21st dynasty, one of that line of ambitious pontiffs who, at a time of national decay, mounted the Egyptian throne. That the tomb of the Deir-el-Bahari was the resting-place of Herhor himself and his family appears from the discovery of their mummies at the same site along with 6000 sepulchral objects, some of which are already filtering to Europe, and others discovered at least ten years ago, already enrich the collections of the Louvre. The numerous duplicates of the smaller and portable objects can neither be all retained in the country, nor is it desirable they should be in the interests of science, for the interest would be languid which allowed them all to remain on the banks of the Nile. The reason why these archæological treasures were deposited in the Deir-el-Bahari is quite uncertain, and as the hieratic inscriptions on the shrouds only speak of their removal and condition, the cause is likely for the present to remain undiscovered. The Deir-el-Bahari was built by Thothmes I., II., Hatasu, the ambitious queen, and her warlike brother Thothmes III., as it was a spot especially favoured by the 18th dynasty. Probably the 21st dynasty was descended by the female line from the 18th, for families do not readily become extinct in that direction, and there are living descendants of the Plantagenets at the present day. The resumption of the titular names of the 18th dynasty by the 21st also points to a connection between the two families, although it is difficult to conceive the precise point from which it started. As however the first monarch of the 21st had been a prince of Kush or Æthiopia, and these princes or viceroys were continued in a lineal descent during the 18th and 19th dynasties, it may perhaps be the case that Pinotem I. and II. were descended by that family from the monarchs of the 18th dynasty.

It is not necessary to dwell on the mummies, but some of the facts mentioned by Mr. Villiers Stuart in his work are remarkable, such for example as the wailing of the Arab women along the Nile on their removal by the steamers to the Museum of Boulaq, for although professional mourners the lamentations of these women were spontaneous and gratuitous. On the arrival of the mummies at Cairo, that of Thothmes III. was unrolled, and that illustrious soldier, a little man, a martial pigmy of the most fragile mould, far more fragile than the flowers with which he was surrounded, vanished like a dream after, as it is said, a rapid photograph had been taken of his features, so that only a carte de visite of his remains has been left for posterity. Rameses II. was a hero of the grenadier type, for his height is at least six feet, but he has not been unrolled, the loss of Thothmes III. having discouraged the Boulaq authorities, so that for the present the vexed question of his features, whether the heroic aquiline nose or the ordinary flat Egyptian, remains in abeyance. The other mummies which have been partly denuded are the priest Nebseni, of the 18th dynasty, whose features are good Egyptian, and Pinotem II., whose capacious mouth and thick lips announce a Nigritic origin or intermixture of blood; others, as Isiemkheb and Makara, have been left in their bandages for a future period to unravel. The queen Notemut, the grandmother of Makara, and a remote progenitor of Isiemkheb, had however hair streaked with silvery gray, and was an old woman still retaining the coquetry of a careful plaiting of her locks. Some of the family were of mixed origin, and when was the Egyptian race otherwise, except when foreign conquests introduced other blood into the country. The greater portion, however, of Mr. Stuart's work is occupied with the description of the leather canopy of the queen Isiemkheb. This ancient pall was composed of numerous pieces of leather tanned by the bark of the *sont* or acacia, and sewn together by red cord, and is supposed to have covered the mortuary cabin of the sacred boat or horse, to which it formed a kind of baldacchino. It is exceedingly brittle, and the colours are still well preserved, the centre 9 feet long by 6 feet wide, and divided into two equal sections, one of which is covered by pink and yellow rosettes on a blue ground, the other displaying six flying vultures flying with extended wings and holding feather sceptres in their claws; they are separated from one another by horizontal lines of hieroglyphs, the name and titles of Masaharuta, high priest of Amen Ra, the deity of Thebes, and a row of pink rosettes on a yellow ground. On either side is a flap divided from the central section by four bands of colours—blue, red, yellow, and green—and further divided by a border of spearhead pattern. Below this comes a row of panels containing a row of emblematical devices, predominant amongst which is the scarabæus, flying with extended wings, thrusting forward the solar disk—emblems of the sun-god—but having with this emblem the representation of a gazelle, supposed to be the favourite of the queen, twice repeated, a singular representation of two united ducks, and ornaments like the Greek antefixal and the cartouche or royal name of Pinotem II. seven times repeated. Below this is a border of pink and blue chequers at the bottom, with a broad kilt of pink or perhaps originally scarlet. This magnificent work of leather measures 22 feet 6 inches in length, and 19 feet 6 inches wide, containing a space of 201 square feet of leather. It is the most remarkable object next to the historical mummies of the whole collection, and exhibits the greatest technical skill in preparation, and artistic excellence in execution and design. Its age is somewhere about the time of Solomon, but the length of the reigns of the monarchs of the 21st dynasty lies entombed in the vaults of the Serapeum, which contained the 24th, 25th, and 26th Apis mummies, and which Mariette found practically inaccessible from the collapse of the vault. The period, however, was that of foreign alliances, as shown by the flight of Adad, the Idumæan prince, to Egypt, and his marriage with the sister of the queen. Besides the devices the canopy was ornamented with a hieroglyphical inscription, the purport of which appears to be that the queen in the future state was in the arms of Khonsu, one of the deities of Thebes, son of Mut and Amen, "redolent with perfumes sweet as those of Punt," the present Somali or Guardafui, and "crowned with flowers." Those found in the coffins of this period, and which still preserved their original colours, have been determined to be blue larkspur, yellow mimosas, or acacias, and the white lotus, besides which, according to Mr. Stuart, a moss was discovered in the coffins resembling a kind found only in Greece. The coloured plate of the canopy which accompanies this part of the work gives an idea of the brilliancy of this remarkable piece of leather embroidery as it appeared nearly three thousand years ago. Specimens of this leather canopy, which have been brought to England, show that the colours with which it was painted or dyed still retained their original lustre. From some unknown circumstance they have, like the flowers, never paled by the effects of time.

In his commentary on the text, which it is unnecessary to follow here in detail, Mr. Stuart has given an account of the scarabæus, known as the *Copris Isidis* of Savigny, and detailed a fact not generally known or described in the account of that insect. Instead of propelling the clay ball or pellet or the dung cased in with clay as the other kinds of this family are said to do with their hind legs, the male *Copris Isidis* carries the ball on its head and neck, for which the peculiar formations of the horns and projections of the thorax are specially adapted. One has been found wending its way over the ground with its spherical load, another has been knocked down bearing it as the beetle hummed his drony flight through the air.

Besides the description of the leather pall, Mr. Stuart gives some account of the recently discovered pyramid of Pepi at Sakkarah and that of Haremsaf. The interior of these pyramids, unlike any of the others, was covered with incised inscriptions coloured green, a peculiarity seen also on some sepulchral tablets. The inscriptions of these pyramids are mythological phrases, consisting of formulas like those of the Ritual comparing the passage of the soul of the deceased kings after death through the heavens to the movement of the constellation Orion and the course of Sothis or the Dog Star. Amongst the other new facts mentioned in these inscriptions is that of the tree of life, which is placed in the island of the blest amongst the pools of the fields of the Aahlu or Egyptian Elysium. A new light is shed on the earlier mythology by these texts, which chiefly turn on the Nut or goddess of the Ether, from whom Osiris and the monarch in the character of that god is descended. These remarkable texts have been translated by Brugsch-Bey, and Lauth. It is much to be regretted that these inscriptions are so entirely religious, and that these earliest of hieroglyphic monuments offer no contribution to the history of that remote period, Meidoum, is surrounded by tombs, in one of which the author found the name of Senofru of the 3rd dynasty. The attempts to solve the antiquity of this sepulchre from other sources has failed like all the earliest works of Egypt; for the passage is uninstructive, some scribes of a later age have scrawled or scratched a memorandum of a visit, but the walls are otherwise silent, and the chamber has not been found in which the royal tenant was deposited. The mastabas of the age do not abound in relics, and the antiquity of some of the terra cotta vases has been impugned, the criteria of the different kinds of pottery being obscure. At Dashour the author found a very early tomb of a person named Afoua, but although the style of art announced a high antiquity, the inscriptions curt, and in the oldest form, offered no novel points of interest, they were like those of the slab of the 3rd dynasty at Oxford, supposed to have been brought by Greaves from Egypt.

Mr. Stuart has published the tomb of Rameses, the governor of Thebes, in the reign of Amenophis IV., and the so-called Khuenaten, and enters into a discussion of the difference between Amenophis IV. and the heretic monarch. The general idea is that Amenophis IV. adopted the worship of the sun's disk soon after his accession, and altered his name from Amenophis, or "the peace of Amen," to that of Khuenaten, or the "splendour of the disk," in honour of the orb of heaven, whose worship he had substituted for that of the Theban god. The fact that the features of Amenophis and Khuenaten essentially differ, the one depicted as a rotund youth, the other that of a haggard septuagenarian, had long attracted attention, and been explained on the hypothesis that the portraits of Egyptian royalty were conventional, and therefore not to be depended on, and that the introduction of the new worship had unshackled the technical details of the Egyptian artists. But who was the mysterious Khuenaten? was he an emasculated virility of the harem, or a withered senility of the Nigritic race who had ascended the throne of Egypt? Was he possibly the old queen Tii, who, ambitious of power, had assumed manly costume and, attended by a mock or daughter queen and attendant princesses, endeavoured to set up a new capital and a foreign cultus at a small but rival capital. All is mystery, the facts pointed out by Mr. Stuart of the different features which could not change with the same facility as the name, the different functionaries of the two courts, the strange and servile homage paid by the courtiers of the old heretic and perhaps impostor, the copious bribery of the novel monarchy only add to the unsolved problem, and are not the least interesting part of the work. The identity of the two monarchs as two single gentlemen rolled into one will be long contested, as even the tomb at Thebes gives the same name and titles to the erased and mutilated heretical forms of Khuenaten. Amongst his miscellaneous plates are one of the mummy of Thothmes III. in its bandages, a box of the queen Makara, and some mummies of the find at Deir-el-Bahari.

These are also known from the photographs of M. Emile Brugsch, attached to the report of Maspero. Some discussions and examples of the Indo-Germanic nature of the Egyptian language are given; but this branch of philology is a knotty point, for the Egyptian language is not of a decidedly Indo-Germanic construction, although many of the words undoubtedly have Indo-Germanic analogies.

The main interest of the work, however, centres in the monuments of the Deir-el-Bahari, especially the leather canopy of Isiemkheb. There are, however, in Egypt such an enormous mass of unpublished monuments and inscriptions that even the Deir-el-Bahari find is not to compare with the inscriptions on the temples of Denderah and Edfu, and those of the caves of Siut.

HYDROGRAPHICAL SURVEYING

Hydrographical Surveying; a Description of the Means and Methods employed in constructing Marine Charts. By Capt. W. J. L. Wharton, R.N. (London: Murray, 1882.)

CAPT. WHARTON, who has had considerable experience in nautical surveying, having been in command of surveying vessels for nearly ten years, has devoted his time, during the short interval he has been unemployed, to writing a work on this part of the naval profession which he modestly describes, in his preface, as an endeavour to collect together information, which has existed for years in a traditionary form amongst surveyors, for the benefit of young officers who may wish to devote themselves to surveying work in the future.

A book of this sort was certainly much needed as since the time of Sir Edward Belcher, only one treatise has been written by a naval surveyor—Capt. R. Mayne, R.N., C.B.—and we think Capt. Wharton deserves the thanks of the profession for his exertions, and we hope to see his work adopted as the text-book for instruction at the Royal Naval College.

Before however reviewing Capt. Wharton's treatise we propose to state briefly what we consider to be the requirements of a nautical survey.

The perfection of marine surveying appears to us to be the representation in a graphic form, readily understood, of the coasts and harbours of the world with their various off-lying dangers; marking distinctly the various features of high and low water lines, showing the dangers to be avoided and the channels available for navigation, placing prominently on the chart those objects on the land which serve best to ascertain the position of a ship, and subordinating all other features to these objects, so that the channels to be used, and the marks by which those channels can be recognised, are easily distinguished; as well as representing the set of the tides and currents and the errors of the compass. To execute such a survey it is evident considerable care must be bestowed in ascertaining accurately the positions of the land marks, as on these depend the whole of the work, but this accuracy need not be carried to such a degree of minuteness that it cannot be shown on the chart; for, after all, the principal object of a *chart* is to show the soundings; and enough care has been bestowed on the land-marks if their positions are ascertained with sufficient precision for soundings. Of course circumstances occasionally arise when, from other causes, it may be advisable to modify this arrangement, but not for the purpose of navigation.

Capt. Wharton appears to have kept these objects steadily in view in writing his work. The work commences with a description of the instruments used in nautical surveying, which, although previously given by Heather and by Simms, cannot be considered out of place, and then gives a description of marine surveying in general, afterwards entering into particulars. We regret that in the description of the sextant the important errors of centering and graduation have been overlooked.

We much commend the following remark at p. 54, too often ignored by surveyors:—"The accuracy necessary in many details of a chart depends very much upon its scale. Over-accuracy is loss of time. Any time spent in obtaining what cannot be plotted on the chart is, as a rule, loss of time."

Of course the scale on which a survey should be executed should be settled after due consideration. It is evident that an inaccessible coast, off which there is deep water, does not require the same accuracy of delineation as a coast studded with bays and harbours, or off which numerous dangers exist; or those portions of the globe little frequented by shipping the same care as the coasts of the United Kingdom. These points must to a great extent be left to the officers in charge of a survey, but the scale once settled no time should be wasted over details which cannot be shown on that scale.

Capt. Wharton's remarks on soundings are excellent. There is no doubt that this, the most important work of the marine surveyor, is very monotonous. To sit in a boat day after day, from early morn to dewy eve, marking in a book soundings and angles, with the salt from the spray drying up one's skin, and the sun blistering one's nose requires more than ordinary zeal, patience, and perseverance; and only long practice enables the surveyor to really take an interest in this work. Young surveyors should, however, remember, that every other detail is subordinate to this, and that until they can really sound, thoroughly, over a given patch of ground without loss of time they cannot be considered masters of the profession.

Capt. Wharton's remarks on obtaining latitudes and running meridian distances are excellent. We think indeed that, in the latitude, the same results might be obtained with less figures, but it is by no means easy to draw a hard and fast line.

In the remarks on tides, no mention is made of the importance of referring the result obtained to a fixed mark on the shore, nor any observation as to the diurnal inequality, and consequently the necessity of, on all occasions, when practicable, registering both day and night tides. In the Eastern Archipelago the diurnal inequality is in some places 4 to 5 feet, and in Australia the mean tide level also differs at different times. These facts appear to have escaped Capt. Wharton's notice, but probably will be inserted in another edition.

In the remarks on searching for Vigias, and ascertaining the position of a ship at sea, Capt. Wharton seems to think accurate observations cannot be obtained, as he asserts the position of a ship to be doubtful to three miles.

On this point we must differ from him, as long experience has proved, to our own satisfaction, that provided the weather is fairly clear the position of the ship can be obtained to half a mile. Nor in asserting this do we rest on single evidence, as Capt. Moriarty, R.N., C.B., in the *Great Eastern*, had no difficulty in picking up the end of the Atlantic cable when it had been slipped from the ship.

The fact is the great error in sea observations is due to the refraction of the horizon, but it must be borne in mind that, excepting in shallow water, this is but slight, and that it can always be corrected by observing on opposite sides of the horizon.

By taking advantage also of the bright planets passing the meridian in the day time good observations can be obtained for latitude and longitude *at the same time* (a great point), whilst the sun is above the horizon, as well as at sunrise and sunset, when by Sumner's method three or more stars can be combined to give the position. We admit that constant practice is required to take these observations accurately, but they *can* be obtained, and as it is very useful to be able to make certain of a ship's position, as often as possible, all officers should practise themselves in observing both Venus and Jupiter with the sun above the horizon.

Whilst however not agreeing with Capt. Wharton on some few points, we think his work will be found most useful, not only for young officers taking up surveying but also as a book of reference for older surveyors, and personally feel much obliged to him for combining in one volume so many useful remarks and tables which have hitherto been only in MSS. or pamphlets.

THE HORSE IN MOTION

The Horse in Motion as shown by Instantaneous Photography; with a Study on Animal Mechanics, founded on Anatomy and the Revelations of the Camera, in which is demonstrated the Theory of Quadrupedal Locomotion. By J. D. B. Stillman, M.A., M.D. Executed and Published under the Auspices of Leland Stanford. (London: Trübner and Co., 1882.)

THE above is the somewhat long title of a large and important work issuing from the well-known Cambridge (U.S.) University Press. Long as is the title, the name of the principal contributor to the volume is left unrecorded there, though indeed even a cursory glance over its contents shows how much indebted is the whole question of the mode of motion in the horse to the elaborate series of investigations of Mr. J. Muybridge.

Leaving aside the anatomical and teleogistic arguments of Dr. Stillman, as contained in some hundred pages of letterpress, we cull from a postscript to the same the following interesting information, which we give as we find it in the book. Some time in 1872, Mr. L. Stanford, of Palo Alto Farm, in California, had his attention called to the very controverted question as to the action of a trotting horse, and conceiving the idea that the photographic camera might be made available to illustrate the action, he, according to the authority before us, consulted with Mr. Muybridge and induced him to undertake some experiments in instantaneous photography. Some ten years ago, a photograph taken in the space of the one-twelfth of a second was considered quite a success, and it would seem that the experiments made then by Mr. Muybridge were inconclusive. In 1877 Mr. Muybridge, however, renewed his experiments. A few pictures were taken of "Occident," a noted trotter belonging to Mr. Stanford, while he was in motion, and one of these, representing the horse with all his feet clear of the ground was enlarged, retouched, and distributed. This result was so extraordinary and so successful, that it was determined to try others on a more extended scale. It was assumed that if one picture could be taken instantaneously, an indefinite number might also be taken, and so the various positions assumed by the horse in a single complete stride could be illustrated.

Mr. Muybridge was authorised to procure the needed apparatus, and a building suitable to the purpose was erected on Mr. Stanford's farm. By 1878 preparations were complete, and every resource of the photographic art had been provided. Twelve cameras were placed in the building at intervals of twenty-one inches, with double shutters to each, and these shutters were so arranged that the whole series of exposures were made in the time occupied by a single complete stride of a horse. The very ingenious mechanism invented by Mr. Muybridge it would be impossible to describe without the assistance of illustrations, but it may be stated that he was thereby enabled to double the number of his cameras, and the whole of the large series of twenty-four figures each, which are used to illustrate this volume, were taken by him. They were very accurately taken, and the heliotypes are perfect transcripts of the original photographs.

Thanks to the zeal and energy of Mr. Muybridge, and the liberality of Mr. Stanford, we are now enabled to see for ourselves the various attitudes assumed by a horse in running, trotting, leaping, and the result is most strange. It would seem as if most civilised nations had failed to recognise the true action of this noble quadruped, as if all had settled down into being content with a conventional idea of how a horse in motion ought to be represented. Now our artists will have no excuse; they can directly interrogate nature, as represented to them in these silhouettes, no doubt at first they may follow her with fear, for some of the positions look strange, not to say grotesque, but soon both artist and the public will have learnt to recognise the truth: and once this is so, the old style will be in its turn regarded as grotesque, and as representing but an early stage in the development of art.

Mr. Muybridge's photographs will be of immense importance to all art students, and they should be attentively studied by all admirers of the horse. A few other photographs are given in this volume of the various stages of motion in the cow, dog, deer, and boar.

OUR BOOK SHELF

Unexplored Báluchistán: a Survey of a Route through Mekrán, Bashkurd, Persia, Turkistan, and Turkey. By Ernest A. Floyer. (London: Griffith and Farran, 1882.)

AN entertaining book of travel, but by no means an exploration of "Unexplored Báluchistán," as is indeed sufficiently evident from the sub-title. Nevertheless, Mr. Floyer has investigated and partly solved some interesting geographical questions in the little-known province of Bashkurd (Bashakard), on the Perso-Mekrán frontier, which he visited on two separate occasions during the years 1876-7. This region, which had been merely skirted by Goldsmid, Lovett, Ewen Smith, St. John, and others connected with the Perso-Balúch Boundary Commission of 1872, and with the development of telegraphy in Persia and Mekrán in 1873-4, was ascertained to comprise six separate territories or districts — Gavr and Pa.ment in the east, Jagda in the west, Marz and Pizgh north and south respectively, and Daroserd with the capital, Angurhán, in the centre. The town, which appears to be a place of great natural strength, was found to lie in 26° 40′ N. lat., 57° 55′ E. long., or about thirty miles from the position assigned to it on Major St. John's map. The Aphen-i-Band range, between Daroserd and Pizgh, was crossed near its western extremity, and ascertained to run east and west under 26° 30′ N., at a mean elevation of 3600 feet, the culminating point of the whole province being apparently the Gu-Koh peak (6,400 feet) in the Parment district.

A survey of the Ab-washur water-parting, between Bashkurd and Hormuz Strait, considerably reduced the supposed eastward extension of the Mináb basin, and showed conclusively that it was in no way connected with the Bampur River, which many geographers have hitherto made to discharge through the Mináb into the Persian Gulf. Mr. Floyer now argues with much force that the true outlet of the Bampúr is the Sadích (Sadaich), which reaches the coast in 58° 40′ E., in the Gulf of Omán, and which seems to flow from the Shahri country, through the Shimsani Pass, in the Band-i-Marz range. He found that where he crossed the Haliri in 28° N., 57° 40′ E., it was already a considerable stream, 90 feet broad, and $4\frac{1}{2}$ feet deep. The furthest head-waters of this important river, of which next to nothing was previously known, are in the Jemal Bariz range, whence it flows in a south-easterly direction to the Rudbar and Shahri districts. Here it would be almost necessarily joined by the Bampúr River, coming from the north-east, and the united stream, whose further course has hitherto remained an unsolved problem, would appear to flow thence through the Shimsani Pass southwards to the Sadích. Hence the Sadích would seem to be the lower course of the Haliri-Bampúr, thus draining nearly the whole of the region in south-east Persia, between 57°–61° E., and 25° 30′–29° N. But this interesting point cannot, of course, be finally determined without a more thorough exploration of the Rudbar and Shahri districts between Bampúr and the Ab-washur water-parting.

The work, whose chief fault is its misguiding title, is written in a pleasant, vivacious style, and contains much useful information touching the ethnical, social, and linguistic relations of the Balúchi tribes on the Perso-Mekrán frontier.

A. H. KEANE

A Synopsis of Elementary Results in Pure and Applied Mathematics: containing Propositions, Formulæ, and Methods of Analysis, with Abridged Demonstrations. By G. S. Carr, B.A. Vol. i., Section ix. (London: C. F. Hodgson and Son, 1882.)

IN our notices of the previous sections we have sufficiently indicated the scope of this work. The present section is devoted to the integral calculus, and takes up its numbered articles at 1900, and closes at 2997: the pagination being pp. 313–440 of part ii. of vol. i. The same honest work, for which we have already commended the author, is conspicuous here, and the utility of having such a handy manual on the calculus is evident. It would be impossible to furnish here the results of a thorough examination of the text; the preparation for such a task would take up a very long time; but we would recommend a testing of the several parts to which a reader may have occasion frequently to refer, so that the book might be consulted with full confidence. We are glad to find that the likelihood of the occurrence of such errors as we mentioned in our notice of the first part, is reduced to a minimum by the very careful method of revision now adopted by Mr. Carr. We have much pleasure in commending this new section to the notice of our mathematical readers.

A Collection of Examples and Problems on Conics and some of the Higher Plane Curves. By Ralph A. Roberts, M.A. (Dublin: Hodges, Figgis, and Co., 1882.)

THESE Examples will serve as an excellent compendium of results to a student who is working through Dr. Salmon's Treatises on Conic Sections and on the Higher Plane Curves. In fact it was whilst the author was reading the above-named works that he conceived these useful illustrative exercises. Mr. Roberts shows himself to be an apt mathematician, and to have a very extensive acquaintance with the classes of curves considered. These are mostly curves of the second, third, and fourth orders. The Problems have been, in general, suggested by Dr. Salmon's treatises and by Dr. Casey's Memoir on Bicircular Quartics: Mr. Roberts also acknowledges his indebtedness to Darboux's Sur une classe remarquable de courbes et de surfaces algébriques. Occasional explanatory matter is thrown in here and there, and concise proofs are given in several cases. As the text-books contain a limited number of examples, this work will be a useful supplement to them. We like almost everything about the book except the paper, and that appears to us to be of a very inferior character.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Recent Unseasonable Weather

IN view of the recent unusually cold weather in England and Scotland, which has been so well described and proximately explained in last week's NATURE, the following paragraph, extracted from the *Standard* of June 15, appears to me highly suggestive, especially as regards one of the probable causes for the "unwonted high pressures" on the northern side of the depression which is accused of being the immediate source of these unseasonable conditions:—

"News from Iceland states that the Spitzbergen floe-ice surrounds the north and east coast, entirely preventing navigation. A Norwegian steamer endeavouring to reach Bernfiord, on the south-east coast, last week, was caught in the ice and had to put back. Owing to the presence of these immense ice-fields vegetation has made no progress, causing a great loss of horses and sheep through starvation. Epidemics of measles and small-pox have been introduced into the island from Europe, and are making extensive ravages among the population; the former is especially prevalent in Rejkjavik."

Now it has been ascertained with some considerable degree of certainty by Messrs. Blanford and Eliot, the Government meteorologists in India, that a heavy winter snowfall over the North-west Himalaya exercises a marked and prolonged influence in lowering the temperature and elevating the atmospheric pressure and thereby directly affecting the winds and weather, over the whole of Northern India, and parts of Central India; and indirectly to a much greater distance. Turning to Europe, we find the distance from Rejkjavik, on the west coast of Iceland to London is about 1140 miles, or about the same as from Lahore to Calcutta (1080 miles), while from Cape Horn on the east coast of Iceland to Edinburgh the distance is only 750 miles, or about the same as from Calcutta to Agra. To any one familiar with Indian weather charts or the meteorology of that country, it would appear absurd not to attempt to correlate the meteorological conditions at places so comparatively near as the above-mentioned towns; and in fact experience has shown that the meteorology of the Punjáb is not only intimately connected with that of Lower Bengal, but also with that of Southern India. If therefore it has been found that an abnormally heavy snowfall in the North-West Himalaya, such as that which characterised the winters of 1876-77 and 1877-78, exercised a marked effect on the meteorology of Northern India, which was felt at places situated 1000 miles or more from the seat of action, may it not be reasonably inferred that the presence of a large mass of ice or snow in the Icelandic area would be likely to give rise to similar atmospheric conditions over these islands? It seems therefore not at all improbable, that the abnormal weather during the past few weeks may be directly due in some considerable measure to the coincident appearance of large masses of ice off the eastern coasts of Iceland, like those which, from the account in the *Standard*, appear to be at present prevailing to an unusual extent.

In the case of India an abnormally heavy fall of snow in the

Himalayan zone is found to be associated, not only with the subsequent conditions already named, but also with an *initially*, and therefore according to experience *subsequently* weak southwest monsoon, which in its turn invariably causes local, if not general drought and famine. These heavy snowfalls are found to have a tendency to recur at the minimum sun-spot epochs, and are proximately due to some condition of the upper anti-monsoon current, at present not exactly known, by which a larger amount of vapour is deposited in the winter, on the Himalaya as snow, and on the North Indian plains as the "winter rains."

It does not appear that we can so readily account for the occurrence of the present ice-floes off Ireland or for the large masses which have been encountered this spring in the Western Atlantic. They must however to some extent be due to the unusually warm winter which seems to have prevailed pretty uniformly over the North Atlantic and North-West Europe, and which has detached a larger proportion than usual of the Arctic ice-fields. And though it is improbable that we shall find any such regular periodicity in the amount of these ice-floes in the Atlantic as in that of the Indian winter snows and rains, it is worthy of notice to observe that they have a decided tendency to occur to an unwonted extent about the times of maximum sun-spot—like the present. Thus Prof. Fritz, of Zurich,[1] gives the following as the list of years in which floating ice was found most abundantly in the lower latitudes of the North Atlantic:—

Years of greatest frequency of floating ice.	Epochs of maximum sun-spot.
1789	1788·1
	1804·2
1816–18	1816·4
1828–29 1831	1829 9
	1837·2
	1848·1
1862–64	1860·1
1868 1869	1870·6

It is also interesting to notice that in 1862 Heis's "Wochenschrift" mentions that the floating ice-masses in the Atlantic caused "a noticeable cooling of the weather in *June* over Europe." And it is further significant to find in a detailed list of the ice met with every month in the Atlantic by ships belonging to the North German lines from 1860 to 1869, that 1868 and 1869 (the year in which similar weather to the present is mentioned as having been observed by the writer of the paragraph in NATURE) were the years in which the greatest quantity of ice was encountered. Though I agree with Dr. Hann in attributing more importance to the *tropical* than to the *polar* area, in influencing the *general* weather of these latitudes, I think it very probable on theoretical grounds that we are relatively more influenced by the *latter* area in *summer* and by the *former* in *winter*, and that just as it has been inferred that the regular recurrence of periods of diminished temperature in Europe, is due to the regular movements of the ice in the polar area so we may reasonably conclude that abnormal movements of the ice, especially in the Spitzbergen area, are likely to produce periods of abnormal coolness such as that which at present prevails. In any case the moral to be drawn, if we really do intend to solve the weather problem, is by all means to have a meteorological station in Iceland, and endeavour to study the weather as we are fortunately able to do in India, on a *large scale*, instead of merely confining our attention to the minute range of conditions we are able to observe within the limited area of these islands.

E. DOUGLAS ARCHIBALD

The Analysis of the Tuning Fork

IN NATURE last week there is a short description of Mr. W. F. Stanley's well-devised experiments, by which the tuning-fork "is shown not to depend upon a vibrating ventroid."

Few persons would readily obtain the experimental steel rod, or would care to attempt the feat of sawing through the bend of the fork down into the stem, and some musical readers may like to know that (missing, of course, the pretty effects) there is a less arduous way of arriving at the conclusion to which Mr. Stanley has directed attention. By very simple experiments I have been accustomed to show that Chladni's analysis, as generally accepted, is not in all particulars borne out by the evidence of facts. If a vibrating tuning fork is held in its upright position by means of a knife-blade passed through the prongs, pressing upon the inner bend so that the stem is in contact with the table, without its being held by the fingers, there will be a communication of vibrations fully as strong as when held in the usual manner, with variation of intensities according to differences in the degrees of pressure. In this experiment the fork at its bend is subjected to pressure both above and below. The argument, therefore, is that the existence of a segment in transversal vibration, occupying the bend of the fork as figured in Chladni's analysis, is incompatible with the evidence. As in all musical instruments, the communicating of transversal vibrations from one solid to another is invariably through the nodes, and as segments are always destroyed by firm pressure, it seems clear that the analysis should be amended. If a vibrating fork is drawn across a stretched string with pressure, the prong passing from the bend towards the point or end, the integrity of the vibrations of the fork is not impaired, and there is but a slight transference of vibration to the string; but it is otherwise with respect to a stretched wire, as when the prong comes into contact with the wire, its vibrations cease; the wire will not be subordinated to the coercive activity of the prong as the string is; yet if the fork is placed with the prongs astride the wire, so that the bend, at the seat of the alleged segment, rides upon the wire, the wire readily conveys the vibrations, and acts as a sound-post. It may be shown that the stem of the fork acts likewise as a sound-post, since we may substitute a free stem; if a vibrating fork is held by the stem, and if through the prongs another fork has the shoulder of its stem pressed upon the bend, then, when the point of this second stem is brought into contact with a solid, the vibrations of the fork are transmitted through it from the bend, with nearly the strength of tone as would be produced by the original fixed stem. The stem itself may be dispensed with as a part of the system, for if the fork is held so that the external part of the bend, where it joins the stem, is pressed against the edge of a table or other solid, its vibrations are not interfered with; neither is the strength of tone diminished, except as in each of these instances, varying in the usual way according to the degree of pressure.

HERMANN SMITH

June 19

"Combing" of Waves

ALL who have watched waves breaking on the sea-shore must have noticed the furrowed or "combed" appearance of the back of a wave as it curls over. If the water is not much disturbed by wind, it is seen, on attentive watching, that this "combing" appears suddenly, and begins at the advancing edge of the crest, and spreads backwards. With small waves a foot or so in height and of long extended front, such as are seen in shallow water, it may be observed that the crest, which in this case rolls down the front of the wave, is at first smooth and even, while the back of the wave is also smooth and unfurrowed, but the edge of the crest suddenly becomes crenated, and almost simultaneously the combing appears on the back of the wave, travelling rapidly backwards from the crenated edge. Moreover a considerable length of the wave appears to be similarly affected almost at the same instant. With larger waves, whose crest falls rather than rolls upon the concave front, I have observed that the edge is at first smooth and even, but that it suddenly becomes uneven, and often fringed with a row or rows of drops, and that at the same instant the combing appears. In both cases, if there is much wind, the regularity of the phenomenon is disturbed, and observation is in other ways rendered difficult. The action is so exactly parallel to something which takes place in the splash of drops, and which I have described in detail in a paper recently read before the Royal Society (see *Proc. Roy. Soc.*, No. 218), that I think your readers may be interested in a brief statement, with special reference to this more familiar case of waves, of the explanation there put forward. The explanation amounts to this:—It is well known that a long cylinder of liquid is unstable, and will, if left to itself, at once tend to split into a row of equal, equidistant drops; the splitting being effected by a constriction of the cylinder in certain places, and a bulging out in others. Again, if a mass of liquid is bounded by an edge whose surface is approximately a portion of a long cylinder, there is good reason for supposing that this cylindrical edge will be subject to similar laws of stability, and that it will tend to cleave in the same way, the surface being forced in in certain places, and out in others. Now a wave's crest presents such a cylindrical edge.

---

[1] In his work, "Ueber die Beziehungen der Sonnen flecken-periode zu den Meteorologischen und Magnetischen Erscheinungen," p. 175.

It will, therefore, of itself, cleave in the way described, and the flow of water will thereby be hindered at the constrictions, and aided at the places of bulging out. Thus lines of easiest flow will be set up, which in their turn will determine the furrows on the back of the wave. The fringe of drops is due to the splitting in a similar manner of the cylindrical jets shot out from the places of bulging, where the flow is aided. Indeed, much of the seething at the edge of a wave is, I think, attributable to the breaking up of such jets in this manner. In the case of the minute phenomenon of a drop-splash, I have been able, in some degree, to bring this explanation to the test of measurements, which, so far as they go, quite confirm it. The regularly-toothed edge of a spot of candle-wax that has fallen on a cold object, affords in a permanent form a familiar illustration of the same action.

A. M. WORTHINGTON

Clifton College, Bristol, June 20

THE SEAL ISLANDS OF ALASKA[1]

TEN years have only just elapsed since the Government of the United States of America obtained by treaty the territory of Alaska, including the seal islands situated off its coast in the Bering Sea, and at that time although the sealskin trade occupied thousands of hands, and had done so for at least a century previous, yet next to nothing was known of the animal producing the skins, and there was not, even in the museum of the Smithsonian Institution, a perfect skin and skeleton thereof. This state of things has happily now vanished, and through the joint action of Prof. Spencer Baird and the Secretary of the Treasury of the United States, Mr. Henry W. Elliott, was enabled to visit the Pribylov Islands in 1872, and we cannot but admire the zeal and energy which enabled him to reside in these dreary and desolate places all through the seasons of 1872 to 1874 inclusive. While a brief digest of Mr. Elliot's notes were published in 1874, it is only now that he has been enabled to publish a complete monograph on the subject, an emended copy of which, reprinted from the Report on the Fishery Industries of the Tenth Census at Washington in this year, is now before us. It forms a quarto volume of some 176 pages, and is illustrated by two maps and twenty-nine plates of subjects from the author's pencil. The writer's opportunities for observation, it will be noticed, were especially good. The previous observations of Stellar and others left much to be desired. The geographical distribution of the Arctic fur seal (Callorhinus) is very peculiar. In the Arctic waters of the Atlantic they have not been found, in the corresponding waters of the Pacific they are virtually confined to four islands in Bering's Sea, namely St. Paul and St. George of the tiny Pribylov group, and Bering and Copper Islands of the Commander group. On the former two they swarm. On the latter two, though the larger in area, the seals do not occur in such quantities. It seems impossible to avoid the reflection here as to the waste of fur seal life in the Antarctic regions, and along the coasts of South America, from which, as a centre, the Arctic forms, probably, originally came. Not a century ago the fur seals rested on the Falkland Islands in millions for hundreds that are to be found there now, and it seems hopeless to expect that a British parliament could, with all its many labours, trouble itself to frame regulations, such as the Russians and Americans have done, with the object of repeopling, even in time, these splendid breeding-grounds which, on the Falklands, lie in the very track of commerce, and which, unlike the Alaskan Islands, have beautiful and safe harbours.

The Pribylov Islands were discovered by the hardy navigator whose name they bear, in 1786, and one of the islands is called after his sloop, the *St. George*. He took possession in the name of Russia. Almost striking against the island in a fog, the sweet music to his ears of numerous seal rookeries was wafted towards him. For a little time he kept his secret; but he was soon watched, and his treasure had to be shared with others. These islands lie in the heart of Bering Sea; they are just far enough south to be beyond the reach of permanent ice-floes, upon which the Polar bears could have reached them. Fog banks shut out the sun nine days out of ten during summer, and the breeding season. By the middle of October strong, cold winds from the Siberian Steppes sweep across them. By the end of January great fields of sludgy, broken ice bear down on them; and from December to May, or June, they lie ice-bound. It is owing to this constant, cold, moist, shady, gray weather, that these islands are frequented by such millions of the fur seals. Let the sun but shine out, and the temperature rise to 60° F., or 64° F. in the shade, and both seals and natives are at once incommoded by the glare and heat. During the winter of 1872-73 Mr. Elliott, while watching with all the impatience which a man in full health and tired of confinement can possess, to seize every opportunity upon quiet intervals between the storms of sleet, in order to make a short trip for exercise, only got out *three* times, and then only by the exertion of great physical energy. On one occasion the temperature sank to –4°, and the wind velocity, as recorded by one of the Signal Service anemometers, was at the rate of 88 miles per hour. This storm lasted for six days. The average summer temperature is between 46° and 50° F. in ordinary seasons. The cloud effects are, as might be anticipated, something wonderful, but the aurora is scarcely to be seen. The islands are of volcanic formation; their vegetation seems interesting, and algæ (seaweeds) seem to abound. This is the weakest part of the author's report, and it would be well worthy of the Smithsonian Institute to have the whole flora of these islands carefully investigated. Only a few very hardy vegetables are raised on St. Paul's. As yet, rats seem not to have landed on the islands, though mice have become troublesome, and the cats brought to keep the mice in order, have by inordinate indulgence in meat (seal) eating, become wonderfully altered; they are described as "stubby balls," having become thickened, short, losing the greater portion of their tails (in the second and third generations), and their voices are altered into a prolonged, fearful cry, that surpasses anything ever heard in these countries. So bad is this caterwauling, that it even at times arouses the wrath of the sluggish Aleutians. Foxes and lemmings abound on St. George; the latter are not found at St. Paul's. Birds abound, and though fishes are scarce, invertebrate life in the waters of the group seems abundant. The "natives" of the island were about 400 in number in 1880, of whom some eighteen were whites (Russian), and the rest Aleutians. The births never equalled the deaths, but they are constantly being recruited by the Alaskan Commercial Company. Now-a-days the people are comfortably housed and well clothed. Seal meat is their staple food; and by the regulation of the Treasury they can kill, every autumn, an average of twenty-three to thirty young seals for each man, woman, and child in the settlement. As each pup averages ten pounds of good meat, this would show an average of about 600 pounds of flesh meat for each. To this diet they add butter, sweet crackers, and sugar. They are passionately fond of butter. No epicure could appreciate good butter more than these people, and the sweetest of all sweet teeth are to be found in the jaws of an Aleut. The Company allows them fairly liberal supplies of these, also rice and tobacco. As an illustration of the working ability of the natives on the seal grounds, the following shows the actual time occupied by them in finishing up the three seasons' work which Mr. Elliott personally supervised on St. Paul's Island.

In 1872, 50	days' work of	71	men secured	75,000	skins.
In 1873, 40	,,	71	,,	75,000	,,
In 1874, 36	,,	84	,,	90,000	,,

---

[1] "A Monograph of the Seal Islands of Alaska," by Henry W. Elliott. Reprinted, with Additions, from the Report on the Fishery Industries of the Tenth Census (U.S. Commission of Fish and Fisheries). Washington, February, 1882.

This shows the increased ability and consequent celerity of action among the natives.

Here it may be mentioned that by an Act of Congress the exclusive right of taking a certain number of fur seals every year for a period of twenty years on these islands was granted to the Alaskan Commercial Company of San Francisco, subject to certain reservations and conditions. The Company seem to have done far more than they were actually by law required, and the benefit to the people has been no less great than to the Company ; and where it was simply impossible under the old state of things to collect the lawful quota of 100 000 seals' skins annually in less than from three to four working months, it is now done by the same amount of hands in less than thirty days, and so the whole of the skins are preserved at their prime, and it is rare that any of them are unfit to be sent to London, whereas in comparatively recent years, often as many as three-fourths were rejected ; comment on such an altered state of things is needless. Here it may be interesting to note that almost all the raw seal hides are sent to London, from whence, when dressed, they are distributed all over the civilised world where furs are worn. Our reader will surely know that the sealskins as worn by the seals and as offered for sale by the furrier are very different-looking objects. Instead of the sleak, glossy coats familiar to us, the sealskin when on its own owner's back is a very unattractive thing, the fur not being visible, but hidden away under a coat of stiff overhair, which is of a dark gray brown or grizzled colour. Not only is this hair removed, but the whole fur is dyed.

The seal life on the Pribylov group consists not only of the fur seal (*Callorhinus ursinus*), but also of the sea lion *Eumetopias Stelleri*, the hair seal (*Phoca vitulina*). and the walrus (*Odobænus obesus*). Of these it is only the first that is of any commercial value ; but in this work we have some very interesting sketches of the life and manners of the others, and some very characteristic portraits. As our space will not allow us to refer in detail to these, we may here mention the fine figure of an old male walrus, being a life study, forming Plate 21, and the figures of the sea lions on Plate 16. The life studies of the common hair seal on Plate 4 are also very excellent ; this animal, so common in the Atlantic, would appear to be rare in the North Pacific. Although the skin of the sea-lion has little or no commercial value, yet to the natives it is most valuable ; it supplies them not only with its hide and flesh, but they also utilise its fat, sinews, and intestines ; its very lip bristles are in great demand in China for pickers to the opium pipes, and for several ceremonies peculiar to the joss houses. The walruses are of little value unless for their hides ; these are used for covering the frames of boats, and when the latter are thoroughly and constantly attended to they form the best species of lighter that can be used on the islands, standing more thumping and pounding than any sort of a wooden boat or even than a corrugated iron lighter.

It is, however, the history of the fur seal that will chiefly interest the readers of this volume. It repairs to these islands to breed and to shed its hair and fur, in numbers that seem almost fabulous. It seems to be an animal of wonderful instinct ; indeed, our author thinks that few, if any, creatures in the animal kingdom exhibit a higher order of instinct. A male, when in his prime, about 6 or 7 years of age, will measure 6½ to 7¼ feet in length from the tip of his nose to the end of his little tail, and will weigh from 400 to 600 pounds. Its muzzle and jaws are about the same size and form as those of a full blooded Newfoundland dog, only the lips are pressed against one another as in man ; on either side of the muzzle are an expressive pair of large bluish hazel eyes. In one of the plates there is a very excellent portrait by the author, of an old male. When the fur seal moves on land, it may be almost said to step with its fore feet, but it brings up the rear of its body in a quite different style, for after every second step ahead with the anterior limbs, it will arch its spine, and in arching it drags and lifts up and brings forward the hind feet to a fit position under its body, giving it, in this manner, fresh leverage for another movement forward by the fore feet, in which movement the spine is again straightened out. If it be frightened, its abandons this method. "It launches into a lope, and actually gallops so fast, that the best powers of a man in running are taxed to head it." This rapid progress it can only keep up for some thirty or forty yards at most, then it sinks to the earth, gasping and breathless. The adult males are always the first to arrive on the seal-ground, which has been deserted by all of them since the close of the preceding year. These arrivals begin about May 1. Not the oldest, but the most ambitious, land first. Up to June 1 more seals arrive, but about this period the seal weather begins—foggy and moist ; and as the gray banks roll up and shroud the islands, the bull seals swarm out of the depths by thousands, and take up advantageous positions. The labour of locating and maintaining a position on the rookery is a terribly serious business for the late-coming males, as it is throughout all the time to those males that occupy the water-line of the breeding-grounds. A constantly sustained fight between the new comers and the occupants goes on morning, noon, and night without cessation, frequently resulting in death to one, and even to both the combatants. This fighting is done with the mouth. The sharp, canine teeth, tear out great masses of the skin and blubber. One old veteran, specially watched, took up his position on the water-line early in May. He had to fight from forty to fifty desperate battles ; and when the fighting season was over he was there, covered with scars, and frightfully gashed, raw, festering, and bloody, with one eye gouged out, but lording it still bravely over his harem of some fifteen or twenty females. These seals are profound sleepers, so much so that one, cautiously keeping to the leeward, and stepping softly, would find it easy to approach near enough to pull the whiskers of any old male ; but on the first touch the trifler must be prepared to jump back with electrical celerity, if he has any regard for the sharp teeth and tremendous shaking which would await him. On young seals the trick may be played with impunity, but to the great terror and confusion of the little sleepers. While the females and young have but one note, a hollow prolonged bla-a-ting call, addressed to their young : the bulls have the power of uttering four distinct calls or notes. They seem to suffer misery from a comparatively low degree of heat. From the time of the males landing, until the close of the season—about three months—they never leave the stations they have secured for a single moment, and of necessity they abstain during all this time from food of any kind, or water. It is no wonder, therefore, that after such a fast they return to the sea mere bony shadows of what they were.

About the middle of June the females arrive, and, bad as the fighting among the males has been up to this to secure good stations on the land, it is now ever so much worse for the possession of the cows. These latter are much smaller and more lithesome than the males, seldom over 4 to 4½ feet in length. Their heads and eyes are exceedingly beautiful ; their expression is gentle, intelligent, and attractive. The females land on the "rookeries" for the purpose of gestation, and the young are born very soon after the arrival of the females. The females are received by the males on the water-line stations with attention ; they are alternately coaxed and asked up on the rocks, as far as these beach-masters can do so, by chuckling, whistling and roaring, and once up they are immediately under the most jealous supervision ; but owing to the covetous and ambitious nature of the bulls which occupy those stations to the rear of the water-line ones and some way back, the little cows have a hard time of it at the first and when they are few, for no sooner is one pretty creature fairly established in the station of male number one, who has got her there, than he perhaps sees another of her style in the water from whence she has come, and he devotes himself to coaxing the later arrival by the same winning methods so successful before; whereupon bull number two, one station in the rear, observing bull number one to be off guard, reaches out with his long, strong neck, picks up the passive cow by the scruff of her neck, just as a cat does a kitten, and deposits her upon his ground; and this will happen again and again until the little cow will finally find herself several stations back. Her last lord not being exposed to the same temptations as lie on the water level, gives her such care that not only could she not leave if she wished, but no other bull gets a chance of seizing her. When the females have all landed and the harems are full, it would seem that those nearest the water may contain on an average from fifteen to twenty females, those in the rear from five to twelve. The courage of the fur seal is of the highest order. As regards man, it is invariably of a defensive character. Though always on the defensive, he never retreats, but he will not attack; the cows, however, are easily frightened and are timorous. Shortly after the females are landed, the young are born; they are for the first three months of a jet black colour, are about fourteen inches long, and weigh about four pounds. It would seem that they are nursed only every second day, the mothers going off to the fish grounds to get a supply of food, but they may also return to suckle their young at night. When returning in the daytime, each mother at once recognises her own young, though there may be thousands upon thouands all together blaating at once. Before entering into such a crowd, the mother stops and calls out, just as a sheep does for a lamp, and out of all the din she then recognises her offspring's voice, and makes direct for it; but it would seem that the young ones do not often know their own mothers.

Early in August the young seals, now about six weeks old, are taught to swim. If dropped into deep water about this period down goes their bullet-like head, and they are drowned; at first they try their skill in the shallow pools, for a week or two they only flounder about, thrashing the water as little dogs will do. When for the first time they are well launched out they soon turn to the shore, and if by some receding wave they should be left high and dry, they will crawl away for a little distance and, quite exhausted, will coil themselves up to take a short recuperative nap, and then to the swimming lesson again. Once boldly swimming they seem to fairly revel in it. The parents do not in the slightest degree supervise or direct the young in swimming. The young shed their black coat about the middle of October; the second or sea-going jacket, does not at first vary in colour between the sexes, nor does a pronounced difference take place until after the third year. The females bear their first young when they are three years old, and the period of gestation lacks only a few days of a year.

The great herds of "bachelor" seals, numbering perhaps one-third to one-half of the whole aggregate of the 5,000,000 seals known to the Pribylov group, are never allowed under the pain of death to put their flippers on or near the rookeries. These are the seals of most importance to commerce, for with the exception of a few thousand young ones and an odd old male, these are the only ones slaughtered for their hides. They locate them in immense tracts, mostly away from the rookeries, but sometimes the road to these will pass along or through a rookery, where, as long as the bachelors keep to the main road, they are never molested; but if they pry about, it is all over with them, for they are literally torn to pieces. These bachelors are wonderfully gentle, but they are possibly the most restless animals in creation, they never seem quiet, not even in their sleep, they do not fast, as they constantly leave the land for the sea, though this at irregular periods depending a good deal on the weather; on land they sport and roll about as if in perfect enjoyment, curling and uncurling themselves, in fact they seem to be surcharged with a quite joyous life, but when in play they never grovel or bite or seem to show even an angry feeling. It is we have seen very different with them when they are a little older and begin to take upon themselves the cares of a harem. These seals pass a deal of their time in the water, where their gambols are truly wonderful, and the time they can remain under water is, Mr. Elliott writes, "past belief." They are readily, when on land, classified as to age. They shed their fur and hair during August. Passing over a detailed and well illustrated account of the various rookeries, carefully calculated as containing some 3,193,042 breeding seals and their young in 1873, and of non-breeding seals over 1,500,000, and the speculations as to the vast amount of fish consumed by this immense army, we have to notice briefly the chapter on the taking of the seals. Except for food, none but the "bachelors" are slaughtered when their furs are in good trim: the natives get between a herd and the sea, and then gently drive it up to a slaughtering station. In cool and moist weather the seals can be safely moved along at the rate of half a mile an hour; on firm grassy ground three or four men can secure and guide as many as a thousand seals at the same time. They are permitted frequently to halt, rest, and cool, as over heating injures their fur, and so on they go to death, and to supply with their hides the markets of the world. They never show fight, and are as docile as a flock of sheep; the bull seals on the contrary will fight rather than endure the panting torture of travel, so that if any of them get mixed up with a herd of bachelors they are easily let drop out; their fur is of no value. On arriving at the slaughter places the herd is allowed to cool, and then the killing begins; the labour of skinning is severe and trying even to experts; the hide has to be taken off at once. The skins are taken from the field to the salt-house, where they stay for two or three weeks, being pickled; after this they are taken and rolled into bundles of two skins in each package, with the hairy sides out and lightly corded. In this state they go by steamer to San Francisco, where they are counted for the tax, and from thence they are shipped to London.

In a series of illustrative and supplemental notes to this volume, there are a number of very interesting details as to the Russian Seal Islands; as to the Fauna and Flora of the Priblyov Group; a digest of the data in regard to the fur seal rookeries of the South Atlantic and Pacific, and the number of skins taken therefrom. There is a translation of Veniaminov's account of the Russian seal industry at the Priblyovs, 1842; a meteorological abstract for the months from September, 1872, to April, 1873, which was an unusually severe winter; and a history of the organisation and regulations of the Alaskan Commercial Company, under whose excellent management the sealskin trade is now carried on. In concluding a necessarily somewhat brief notice of this excellent monograph, we would congratulate Mr Commissioner Spencer Baird on being the means of obtaining for men of science and of commerce so much valuable information, and we can scarcely give too much praise to Mr. Henry M. Elliott for his most artistic and praiseworthy history of the most interesting of all Pinnipeds.

A DYNAMOMETER FOR ALTERNATING CURRENTS OF MODERATE STRENGTH

THE object of this instrument, which I had the pleasure of bringing before the Physical Society at their Oxford meeting, is chiefly medical. But it occurred to me that a few details, mainly constructive, might prove of interest. It was suggested by Mr. Preece, in consequence of a statement made by me in a paper on "Measurement in the Medical Application of Electricity," read before the Society of Telegraph Engineers. This statement was to the effect that some difficulty still existed in the trustworthy estimation of induction currents of medium strength, such as are habitually used for physiological and therapeutical purposes. The French International Commission had only imperfectly remedied the deficiency by recommending the universal adoption of a particular pattern of induction coil made by a single German firm, and arbitrarily graduated to a "sledge" apparatus. Mr. Preece thought that a dynamometer, which may be regarded as a galvanometer of which the moving magnet is replaced by a suspended coil introduced into the circuit, would answer the purpose; since the deflection of the coil is in one uniform direction, although the currents traversing the circuit are alternate. This very practical hint seemed to offer a prospect of obtaining accuracy in a department of science in which it is much needed. But on examining existing dynamometers I found only Weber's original instrument, which, in spite of its immense value, is fitted only for a well-appointed laboratory, and another, made by Messrs. Siemens for the measurement of very intense electric light currents, which erred on the opposite side of deficient delicacy. The dynamometer of Messrs. Siemens, shown at the French International Exhibition, by means of which the alternating currents of telephones were demonstrated, was probably in the same category, though neither I, nor the president of the Physical Society could obtain any exact details of its internal arrangements.

An electrodynamic balance, described in the *Annalen der Physik* in 1881 by Helmholtz, comes somewhat closer to the requirements of the case, but this, like that of Weber, is a delicate apparatus, difficult of transportation. It might, however, prove excellent as a means of calibrating a less perfect and absolute, but more handy instrument, such as that I was in search of.

Another form of dynamometer had been incidentally named to me by Mr. Ayrton, of his invention, in which the moving coil is replaced by a piece of soft iron which becomes magnetic during the passage of the current. Of this also further details were wanting.

I therefore attempted to make one for myself by the usual method of suspending a coil of wire from two silk fibres within a fixed coil, bringing its two ends to mercury contacts at the lower part, and joining all up in one circuit. Two defects at once appeared. 1. The coil of copper wire was far too heavy to move with the small currents at my disposal; and when it did swing, it continued to oscillate slowly for an unlimited time, giving no satisfactory reading. 2. The mercury contacts caused so much friction as absolutely to stop all motion whatever.

It was therefore obvious that (1) a light coil, and (2) a sensitive bifilar suspension were needed. Both of these must have a fairly high electrical conductivity. The second of these desiderata may be dismissed first. I found at the gold lace shops bobbins of silver-gilt wire, in which the gold is drawn over the silver in manufacture; not merely plated on. These two combined have a diameter of $\frac{1}{500}$ of an inch; which is exactly that of the finest platinum wire commercially made. But whereas the resistance of 1 metre of the latter is 62·2 ohms, that of the former is only 9·8 ohms. An induction shock from Dubois-Reymond's apparatus passed through a metre of this wire has such strength, that I do not wish to try it again, nor should I venture to administer it to an invalid.

It occurred to me that (1) the light coil might be obtained by using fine aluminium wire covered with silk. Messrs. Johnson and Matthey, with their usual courtesy, drew this for me specially, to a diameter of 1-100th of an inch, or even less,[1] and Mr. Rickards, of Derby, completed the operation.

By winding this on a mandril, tying the ring thus obtained with silk threads, and immersing in photographic amber varnish, which I find much less dense, and as good an insulator as Shellac, I obtain a coil composed entirely of metal and silk, which is at once rigid, light, and conductive. One of these, of 1·25 inches internal diamater, not of very fine wire, contains forty-two turns of wire in five layers, its length thus being over four yards. It weighs 6·25 grammes, less than 100 grains, its resistance is about half an ohm.

On suspending this light coil from two threads of the silver-gold wire named above, I found its deflections considerable, and easily measured, even with moderate currents. It could easily be made "dead-beat." The bifilar couple was varied by giving the suspending points a sliding motion to and from each other. By also fashioning the suspensions in the form of light vertical springs, the two threads were kept at an approximately equal tension.

Aluminium appears to offer great advantages for employment in such functions as these. It is said in Watt's "Dictionary," that "the electric conducting power of aluminium is eight times as great as that of iron, and about equal to that of silver," where probably the comparison is intended to be made with equal weights, and not volumes. But even if it were lower, it would be abundantly sufficient for the purpose named, as the currents are of high tension, and as the resistance need not be materially less than that of the suspending wires given above. Its specific heat is very great, so that moderate changes of temperature affect it but little. This property might render it valuable for the fabrication of resistance coils.

It was stated at the meeting that this metal had been tried by Messrs. Siemens, but given up in consequence of the failure of connection in the ends of the aluminium wire. This difficulty I have not found, probably in consequence of the high tension, and also from the fact that the contacts are between gold and aluminium, both stable substances. In any case the difficulty could be overcome by making a gripping contact with a light clamp, such as is already used in watchwork. Nor can Messrs. Siemens' unsuccessful attempt for other purposes be, I think, considered as a distinct anticipation of this. The mechanical advantage of such a light coil in diminishing moment of inertia, and in reducing the force of the bifilar couple, can hardly be denied on theoretical grounds, and is, indeed, borne out by experiment. W. H. STONE

MATHEMATICS AT THE JOHNS HOPKINS UNIVERSITY

FROM time to time we receive copies of the *University Circular*. From two now before us, we make a few extracts, which will serve to show what this young but promising University has done (or attempted to do) in the session 1881-82. The students have been thirty-two in number; of these, twenty followed advanced and University courses, and twelve pursued collegiate courses.

Supreme over the department presides Prof. Sylvester, F.R.S., who, besides editing the *American Journal of Mathematics* and reading papers at the Mathematical Seminary (similar in its character to our own London Mathematical Society), has delivered two courses of lectures—one on the Theory of Numbers (and in especial on an extension of Tchebycheff's theory concerning Prime Numbers), the other on a new theory of universal multiple algebra.

This session on the invitation of the Trustees, Prof. Cayley was called in as *amicus curiæ*, and arrived at

---

[1] The finest wire has not yet been measured in the microscope; it passes through the smallest hole of the B.W.G., No. 80.

Baltimore in December last. At the January meeting of the Seminary, he read a paper "On Two Cases of the Quadric Transformation between two Planes," and has subsequently read other papers, and been a contributor to the *Journal*. But the result of his visit has been the delivery of "a systematic and highly original course of lectures upon Algebraical Geometry, in connection with the Abelian and Theta Functions."

These lectures, we hope, will be given, in book form, to a more extended audience. Besides the ordinary class lectures, given by the able staff of assistant professors, some of whom are well known to mathematicians here, short courses of lectures have been delivered by Mr. C. S. Peirce (who has recently annotated and published in the *American Journal* his father's fine work on "Linear Associative Algebra"), on the Logic of Relatives, by Dr. Story; on the Clebsch-Gordan invariantive theory; and by Dr. Craig, on the Construction and Direction of a Riemann's surface (how these two last courses recall to our minds a departed master.)

Leibnitz somewhere says "Les mathématiques sont l'honneur de l'esprit humain;" if this be so, then the University has done well in assigning so great a part of its time and resources to the study of the higher branches of this department of knowledge. But indeed Johns Hopkins is a true university, for it is catholic in its sympathies, and enfolds in its wide embrace all branches of culture and learning.

In No. 13 is an abstract of a lecture before the students by Dr. James Bryce, M.P., on our English universities.

R. T.

KŒNIG'S EXPERIMENTS IN ACOUSTICS

I.

IN the volume mentioned below[1] Dr. Kœnig has collected the valuable series of researches in experimental acoustics that have been published by him chiefly in the *Annalen* of Poggendorff and of Wiedemann during the past twenty years. Many of these researches are well known in England, having attained to "classic" importance, and their main results are to be found embodied in all the best text-books of acoustics. Other researches of more recent date are yet known only to the few, but will doubtless win their way to general knowledge before long. The most novel points in the book are the late researches of its author with the ingenious instrument known as the wave-siren. This invention Dr. Kœnig has applied to support his views upon the origin of the beats of imperfect consonances, and also to investigate the influence of differences of phase upon the quality of tones. The general nature of the wave-siren has already been explained in the pages of NATURE, but in the sequel we will attempt to describe fully its most recent forms, as applied in the last investigation. In addition to these deeply interesting matters of recent research, there is a mine of wealth contained in the volume. The first chapter deals with the application of the graphic method in acoustics; an equally interesting chapter on manometric flames and their applications occur a little further on. Dr. Kœnig's researches on the standard tuning-fork or "*diapason normal*" are too well known to need comment. The reader will find the whole series of papers collected in Chapter XIII. He will also find notices of an adjustible tuning-fork capable of giving a variety of tones, of a curious tuning-fork clock, of new stethoscopes, of instruments for producing continuous beats audible to a large company of persons, together with researches on the phase of vibration of two associated telephones, on the fixed notes charcteristic of the different vowel sounds, and on several other matters of great importance. He must not, indeed, expect to find deep mathematical insight nor folios of analytical equations. But he will find a perspicuous and fascinating record of experiments planned with rare ingenuity, carried out with honesty, patience, and consummate skill, by the man whose exceptional abilities as experimentalist and constructor have done more than those of any other physicist to make the science of experimental acoustics what it is to-day.

In the present article we shall refer in some detail to Dr. Kœnig's researches on the influence of phase upon the quality of sound.

It has long been an accepted doctrine of acoustics that every continuous sound possesses three recognizable characteristics, viz., *pitch*, *intensity* and *quality*, and that these three characteristics depend respectively upon the frequency, the amplitude, and the degree of complexity of the sonorous vibrations. The third of these characteristics, the *quality* of a sound, has also been denominated "*timbre*" or "*clang-tint*" by those who affect Gallic or Teutonic proclivities in scientific nomenclature. Everyone now knows that, by whatever name this third characteristic is called, it constitutes the almost indefinable yet perfectly recognizable difference which exists between a note as played on one musical instrument and the same note as played upon another. The notes may be the same in pitch and in intensity, but there is a residual difference in quality that the dullest ear cannot mistake.

It was by one of the finest pieces of scientific research by Germany's greatest living physicist, that the true cause of this mysterious "quality" was established. Helmholtz's great work on *The Sensations of Tone* takes for its basis the fact that with every fundamental "tone" or perfectly simple sound there co-exists a whole series of "partial tones," which together with the fundamental make up the mass of sound that we usually call a "note." All our musical instruments yield us complex sounds in which every fundamental is accompanied by a variety of upper partial tones (sometimes called by mistranslation "overtones"; and also, by a far more serious mistake, "harmonics), the number of such upper partials and their relative intensity being a consequence of the conditions of vibration in the instrument. Hence instruments having different kinds of vibrating parts—strings in one, reeds in another, columns of air in another—will emit tones that vary in number and intensity of accompanying partial tones; and the ear taking the mass of complex vibration as a whole will pronounce that there is a difference *in quality*. Helmholtz's theory, in short, asserts that the quality of a tone depends on the following points: firstly, whether there were any upper partials present; secondly, what those upper partials were; thirdly, what their relative intensity toward one another and toward the fundamental note might be. Thus, for example, the thin quality of the notes of wide, stopped organ-pipes, which contrasts both with the full rich quality of the pianoforte notes, and with the harsh, strident, irrepressible notes of the harmonium, becomes intelligible when it is rendered plain that in the first case there is an almost complete absence of upper partials, that in the second the partials, though numerous, are loud only for such partial tones as are concordant with the fundamental, while in the third discordant partials, loud and shrill mingle with the fundamental.

But there is a negative proviso in Helmholtz's theory of a very important kind, namely, that differences in quality of tone depend "*in no respect on the differences in phase under which these partial tones enter into composition.*"[1]

This negative law, which Helmholtz has sought to confirm by various experimental proofs, is a consequence of the hypothesis that the ear unconsciously analyzes complex sounds into their simple elements—the partial tones—each simple (partial) tone actuating a separate part of the nerve-structures of the ear. Before Helm-

---

[1] "Quelques Expériences d'Acoustique." Par Rudolf Kœnig. (Paris: R. Kœnig, 27, Quai d'Anjou, 1882.)

[1] *Helmholtz.* Sensations of Tone (Ellis's Translation) p. 186.

holtz's time, the theory had been propounded that quality depended on the *form* of the vibrations of the wave of sound; but since differences of phase greatly affect the form of the vibration, Helmholtz was forced either to abandon the new hypothesis that the ear thus decomposes complex tones into simple ones, or else to establish by experiment that no difference of phase affected the perception of quality by the ear.

Fig. 1.—Resultant curves formed by compounding together the wave-forms of a harmonic series of simple tones of equal intensity but differing in phase.

The difference of form introduced into a complex vibration by a difference of phase between its components is already known; but Kœnig has brought forward some very striking examples. Fig. 1*a*, for example, gives the curves which result from compounding together the wave-forms of a note and its first eight upper partials, each of the nine tones being of equal intensity. Of the four curves ranged in line the first corresponds to the resultant when the components start at similar phases, each component beginning from zero with descending ordinates. In the second of the row, each of the separate component waves begins with a negative ordinate of maximum amplitude, or differing in phase by one quarter from the first case. In the third the difference is half a wave-length, and in the fourth case three-quarters of a wave-length. It will be noticed how very different these curves are to the eye, though compounded of the same elements. It will also be observed that the curves for

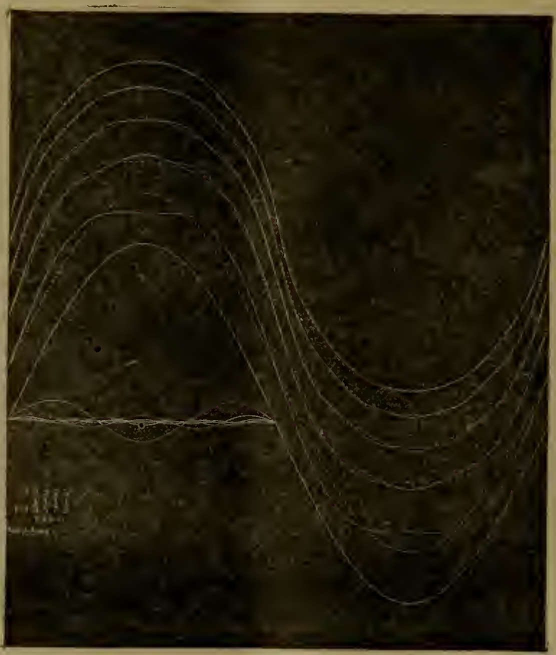


Fig. 2.—Resultant wave-form for odd members of series of upper partial tones when there is no difference of phase.

difference of phase $= \frac{1}{2}$ is a reversed copy of that for which the difference of phase $= 0$; while the curves for phase-difference $\frac{1}{4}$ and $\frac{3}{4}$ are reversed copies of one another Now, according to Helmholtz's theory. all these forms of vibration should yield identical sounds in the ear. Kœnig finds, on the contrary, the startling result that the sounds are perceptibly different in quality. His proof is extremely simple. The curve, calculated graphically with great care, is set off upon the circumference of a cylindrical band of thin metal, the edge being then cut away leaving the shaded portion, the curve being repeated half a dozen times, and meeting itself after passing round the circumference. For convenience the four curves to be compared are set out upon separate rims of metal, all of which are mounted upon one axis to which a rapid motion of rotation can be imparted. Against the indented edges of these rims wind can be blown through an appropriate slit; the whole combination forming a variety of the Wave-Siren described a few months ago in the columns of NATURE (p. 358, vol. xxiv.). It will be obvious that as these indented curves pass in front of the slit the maximum condensation will result when the slit is least covered, or when the point of greatest depression of the curve crosses the front of the slit. The negative ordinates of the curves correspond therefore to condensations, the positive ordinates to rarefactions. Now, according to Kœnig's experiment, the sound is louder and more forcible, with a difference of phase of $\frac{1}{4}$, than in any other case, that with $\frac{3}{4}$ difference being the most gentle and soft in tone; whilst the curves of phase 0 and $\frac{1}{2}$ yield intermediate qualities of tone. Kœnig also finds that by combining simply a note and its octave, the loudest resultant sound occurs when the phase of combination is $\frac{1}{4}$, a difference of phase of $\frac{3}{4}$ again yielding the feeblest resultant. In Fig. 1, *b*, four curves are shown corresponding to the combination of the odd members, 1, 3, 5, 7, 9, of the harmonic series, taken as before as of equal intensity. In this case the form of the waves is identical for the phases 0 and $\frac{1}{2}$ and also for the phases $\frac{1}{4}$ and $\frac{3}{4}$. The latter yield a loud and strident tone as com-

FIG. 3.—Resultant wave-form for odd members of series of upper partial tones when the difference of phase is a $\frac{1}{4}$.

pared with the former, though according to Helmholtz's theory their tones should be alike. It may be objected to these illustrations that in all natural sources of tone one never finds a whole series of partial tones every member of which is equally loud as the fundamental tone. It is more nearly true for most musical instruments that the higher up one goes in the series of partial tones the feebler are they in comparison with the fundamental tone.

Accordingly, Kœnig has combined, as in Fig. 2, a series of partial tones corresponding to the respective frequencies 1, 3, 5, 7, 9, making the amplitude of each partial tone inversely proportional to its frequency. The separate curves are shown in Fig. 2, both grouped about a horizontal line, and also as successively superposed upon the fundamental. The uppermost of the set of curves exhibits the final resultant; which, in this case, where the difference of phase is taken as *nil*, and all the components rise from zero together, is seen to consist of bold, well-rounded sinuosities. In Fig. 3, curves identical in wave-length and amplitude, but differing in phase by $\frac{1}{4}$, are compounded together; but the final resultant shows a wave-form that is practically a zig-zag. Now if these bold sinuosities and zig-zags be cut out in thin metal and curled up into circumferences so as to adapt them to use as wave-sirens in the manner before-mentioned, it is again found that the zig-zags corresponding to differences of phase $\frac{1}{4}$ and $\frac{3}{4}$ yield always harsher and louder tones than the rounded sinuosities that correspond to 0 and $\frac{1}{2}$.

These observations are very remarkable, and have important bearings that must be left for discussion in the next article on Kœnig's work.

For the present we will conclude by observing that more than once it has been pointed out that a certain perception of difference of phase did exist. Sir W. Thomson has suggested that there is evidence of this in the phenomenon of slow beats which by a curious acoustic illusion almost always suggest the idea of something revolving. The writer of this notice had also previously pointed out that in certain cases where a compound sound was led separately to the two ears a difference of phase between the components could be detected.

It may not be generally known that Dr. Kœnig has quite recently republished under the title of "*Quelques Expériences d'Acoustique*" the most important of his recent researches, including those on the Wave-Siren and on the Beats of Imperfect Consonances. The figures herewith presented, and those which will accompany the continuation of this notice, are taken by Dr. Kœnig's courteous permission from this his very valuable contribution to experimental acoustics. S. P. T.

THE RAINFALL OF THE GLOBE

PROF. LOOMIS has recently contributed a paper on this subject to the *American Journal of Science* of no small interest and value. The paper gives the mean annual rainfall at 713 places in all parts of the globe, and the results are graphically represented on a map of the world as closely as can be done by five tints of one colour. These tints represent respectively annual amounts of rain under 10 inches, from 10 to 25 inches, 25 to 50 inches, 50 to 75 inches, and above 75 inches. It is stated that the map is merely a provisional one, it being Prof. Loomis's expressed intention to publish a list of additional observations with a revised edition of the map; and in the meantime he invites the assistance and criticism of meteorologists in furtherance of the work.

The map shows unquestionably the broad features of the geographical distribution of the rainfall of the globe, so that any changes that will be made in a future issue, however interesting and important these may be locally, will only be rectifications of the iso-hyetal lines in some of their subordinate details.

Leaving out of consideration all exceptionally heavy rainfalls confined to limited spots, such as those of Cherapunji, in Assam, which amounts to 492 inches annually, and the Stye, in Cumberland, which is about 190 inches, the heaviest rainfall is met with in the rain-belt which surrounds nearly the whole globe lying between the north-east and south-east trade-winds. Absolutely the largest rainfalls over large regions are to be found where the trade-winds, after having traversed a great breadth of ocean, are forced against and over a breadth of land, of some elevation and extent which lie across their path. Of these the best examples are the highlands of Java, Sumatra, and Assam, in the Old World, and parts of the north of South America, and of the steep slopes of Mexico facing the Gulf of Mexico in the New World, over which the trades or monsoons discharge their moisture so copiously as to raise the rainfall over large tracts up to, and in cases considerably above 200 inches annually. The influence of height is well illustrated by the rainfall of Mauritius; thus, while at the observatory it is 46 inches, it amounts at Cluny to 149 inches on a mean of the same 19 years. Similarly in St. Helena, while near the sea-level it is only 5 inches, at a height of 1764 feet it is 48 inches. In Ascension, no part of which rises to any considerable height, the annual rainfall is only 3 inches, and the whole island is little else than a burned-up desert.

The rainfall is particularly large in mountainous regions in both hemispheres above lat 40°, situated on the eastern shores of the great oceans, and consequently in the full sweep of the strong westerly winds of these high latitudes. Thus large portions of Scotland north of the Clyde, one or two small patches in England, a few spots in Ireland, large tracts between California and Alaska, the south of Chile, and the west coast of the south island of New Zealand have an annual rainfall exceeding 80 inches. Nay, even at Bergen, lat. 60° 23′ N., bathed in the warm, moist, westerly winds of the Atlantic, the rainfall is 73 inches annually, which is the largest rainfall yet observed anywhere at so high a latitude. Those headlands, even though of comparatively small height, which ran out into the sea, meeting the moist oceanic winds, have rainfalls very considerably above the average—owing doubtless largely to the greater friction of land than water on the winds, thus partially arresting their progress, and inducing a more copious precipitation.

As causes of deficient rainfall, Prof. Loomis enumerates five, viz.: (1) a uniform direction of the winds during the year, such as prevails within the regions of the trades, illustrated by the rainfall of Ascension, Sahara, and South California; (2) the prevailing wind having crossed a mountain range, thence descends on the leeside, illustrated by desert of Gobi, Chili, and large tracts in Spain; (3) ranges of mountains so high as to obstruct the free movement of the surface-winds towards the interior, as parts of Central Asia and California; (4) remoteness from the ocean measured in the direction from which the wind proceeds, illustrated by the gradual diminution of the rainfall on advancing eastward into Europe; and (5) high latitudes, since beyond lat. 60°, at a little distance from the ocean, it seldom exceeds 10 inches, and there are apparently large tracts in North America and Asia, where the rainfall is less than 10 inches. As regards this last statement, observation scarcely bears it out, since in Europeo-Asiatic continent, only two stations in latitude the above 60°, viz. Kola in Russian Finland, on the Arctic Sea, and Yakutsk, show rainfalls less than 10 inches, and these are doubtful owing to the short periods over which the observations extend.

The truth is there are other causes powerfully influencing the distribution of the rainfall than these, which an examination of the rainfall of the individual months, notably January and July, best discloses. These causes have their explanation in the systems of low and high pressures, which appear and disappear with season. Of these the most prominent are the low pressures which occupy the centres of continents in the summer months, and the northern portions of the Atlantic and Pacific Oceans in the winter months; and on the other hand, the high pressures which fill the centres of the continents in the winter months, and the high pressures in the oceans immediately to the west sides of the great continents, about lat. 36°, as shown by the Admiralty's physical charts of the Atlantic, Pacific, and Indian Oceans.

To take, as an example, the great summer barometric depression of Central Asia with the winds, flowing in upon it on all sides vortically, carrying with them the moisture of the ocean from which they come. Thus East Siberia is then swept by south-east and east winds, which distribute to westward as far as Irkutsk, in July, a monthly rainfall of 3 inches and upwards. Now since the annual rainfall of this region is all but wholly determined by the rains of the summer months, the extension of these rains inland wholly determines the position of the annual iso-hyetal lines. Again, to westward of long. 100° in Siberia, the rains have their origin in the Atlantic and Arctic seas, and since west and north-west winds prevail from Archangel to Central Asia, they bring with them comparatively so large a share of moisture from the ocean, as to raise the annual rainfall over the greater part of these northern regions to about 20 inches, or even more. On the other hand, on the east side of the Ural Mountains, which drain these winds of much of their moisture, the summer rainfall is much less. From north of the Caspian and Aral Seas, southward to the Persian Gulf, and eastward to the Indus, the summer winds are north-west, and since they thus advance over regions rapidly rising in temperature, little if any moisture is deposited in their train, thus rendering this extensive region one of the largest arid tracts of the globe.

These, with other considerations, indicate that the courses of several of the iso-hyetal lines, where observations are sparse, should be regulated to a greater extent than has been done in the map before us, by the positions of river-basins and mountain ranges in their relations to those seasonal winds, which really determine the annual amounts of the rainfall.

One of the most important points to which attention is drawn by Prof. Loomis, is that more rain falls on the eastern than on the western sides of continents. This remark holds good everywhere, until we reach the higher latitudes of both hemispheres, where the predominating winds become westerly. Thus the rainfall at San Francisco is only from a half to a third of the amount which falls on the coast of Pennsylvania in the same latitude; and about the same proportions, or even proportions still more striking, are seen on comparing Morocco with the Chinese coast, and the west with the east coasts of South Africa, Australia, and South America. The explanation is to be found in the portions of the areas of low and high pressures, with their accompanying winds, during the season whose rainfall determines the annual amounts. On the east side of the continents the prevailing summer winds are south-west, south, or south-east, which having traversed a large extent of ocean, and constantly advancing into higher and colder latitudes, spread a copious rainfall over the regions they traverse. But on the other hand, since the west side of continents in the same latitude lies between the region of abnormally high pressure in the ocean immediately to westward, and the low pressure of the interior, north-west winds in the northern, and south-west winds in the southern hemisphere prevail there; and as they advance into lower latitudes or over regions of a constantly increasing temperature, they deposit little or no rain in their course. Hence, owing to the failure, more or less complete, of the summer rains, it follows that the annual rainfall of these portions of the continents is small.

In preparing the second issue of the map, attention should be directed, in addition to the regions already indicated, to the rectification of the lines of equal rainfall over Iceland, the south-east of Norway, the Gulf of Guinea, the temperate regions of South America, and Northern, Central, and Western Australia, and we feel assured meteorologists will heartily co-operate with Prof. Loomis, and give him all possible assistance in completing the important work he has so successfully begun.

NOTES

The name of Prince Leopold (Duke of Albany) has been added to the General Committee of the Darwin Memorial Fund, subscriptions to which, we may remind our readers, are still being received at the Royal Society, Burlington House, by the Hon. Secretaries, Prof. T. G. Bonney and Mr. P. Edward Dove.

The communication from Greenwich which appeared in our last number, p. 175, showed that in the double magnetic storms of April, the Greenwich times of commencement of disturbance were, for Greenwich, April 16, 11h. 32m., and April 19, 15h. 35m.; and for Toronto, Canada, April 16, 11h. 34m., and April 19, 15h. 34m. The communication in question was followed by one from M. Dechevrens, reporting the magnetic disturbance as commencing suddenly also at Zi-ka-wei, China, at 7h. 36m. on the morning of April 17, and as being as suddenly renewed at 11h. 40m. on the morning of April 20; equivalent to April 16—11h. 30m., and April 19, 15h. 34m. Greenwich time. The outbursts thus occurred at the same absolute time at Toronto, Greenwich, and Zi-ka-wei.

The Prince and Princess of Wales opened the handsome new Technical School at Bradford on Friday. The Prince, in the various speeches he gave showed that he has a real appreciation of the necessity for scientific training in this country, if we are to keep on a level with the other great nations in our industry and commerce.

The Commission appointed by M. Ferry to report on the construction of the rotating dome for the large refractor of the Paris Observatory, has held numerous meetings at the Conservatoire des Arts et Métiers, Col. Laussedat, director of the establishment, being in the chair. Only two projects have been reserved for final choice. M. Eiffel proposes to use a saline solution in a horizontal circular channel placed on the wall to diminish the weight of the rotary roof.

We are glad to learn that owing to the exertions of Admiral Mouchez, magnetical observations will soon be resumed at the Paris Observatory, in subterranean chambers which have been excavated in the newly annexed grounds. These observations will be self-registering by photography, in conformity with the instruments established by M. Mascart at the Collège de France. Direct observations will also be conducted with the old instruments which were used by Arago, which were famous for his prognostications of Auroræ, at a period when, the electric telegraph not having been invented, many days must elapse before the arrival in Paris of news from the northern parts of Europe.

In the course of a few weeks all the International circumpolar observatory parties will have arrived at their different destinations, or be on their way thereto, and on August 1 the observations will commence simultaneously on the common plan framed by the different conferences held in Hamburg in 1879, in Bern in 1880, and in St. Petersburg in 1881. By the present arrangement Russia has three stations, the United States and Germany two each, whilst England, Austria, Sweden, Norway, Denmark, France, Holland, Italy, and Finland maintain one each, of which three—the French, the Italian, and one German—will be established in the Antarctic regions. The total number of stations will thus be sixteen, with a complement of some 150 men. The work will be carried on continuously for thirteen months, and the expeditions will leave their quarters on September 1, 1883. On their return an International Conference will assemble—it is suggested in London—in order to examine the material collected, which will, it is hoped, give important results, particularly as regards meteorology.

"LA LAMPE SOLEIL," or the sun lamp as it is called, from the likeness of its rays to solar light, was successfully tried on Saturday last in the vaults of the Royal Exchange. This lamp is the invention of MM. Clerc and Bureau of Brussels, and is so simple in its action as to require no regulating mechanism. It consists of a square block of marble or dry limestone, having two holes pierced into it from above. The holes slant together until they nearly meet just within the base of the block. Into these holes are inserted the two carbon rods forming the poles of the arc, and the current traversing the partition of calcareous stone between their points heats it to incandescence, and thus a soft white light is emitted from the bottom of the block. This light is remarkably steady, and is very suitable for picture gal-galleries. It was used to light the picture gallery in the recent Paris Electrical Exhibition, and is now employed in the *foyer* of the Grand Opera House, Paris. The limestone is calcined by the current, and the carbons feed themselves by gravity as they are consumed. The ugly shape of the lamp is certainly against its use, unless it be sufficiently well screened from view, but its simplicity is decidedly in its favour.

THE new Report (1880) of the Smithsonian Institution contains among other valuable material, a Bibliography of Sir W. Herschel's writings, a list of his published portraits, and a long and very careful synopsis of his scientific writings. This last occupies nearly 100 pages, and its value to the student is evident. Appended there is a subject-index to the scientific writings of Herschel. The same volume contains the first results of the attempt of the Institute to issue a yearly report of the work done at observatories all the world over; the report covers upwards of 100 pages.

OF the Smithsonian Report, upwards of 200 pages are occupied with a Record of Recent Scientific Progress, in which Prof. Baird writes the Introduction, Prof. Holden, Astronomy, Dr. G. W. Hawes, Geology and Mineralogy, Prof. G. F. Barker, Physics and Chemistry, Prof. Barlow, Botany, Prof. Theodore Gill, Zoology, and Mr. O. T. Mason, Anthropology. Mr. Mason also contributes a separate Bibliography of Anthropology, in which (p. 412) we find the following curious entry—"Vikin's (A.) ship."

ON the recommendation of the Agricultural Chamber in Stockholm the Swedish Government has accepted the invitation to participate in the International Fishery Exhibition to be held in London next year, and granted a sum of about 3000*l.* towards the expenses of representation. The Norwegian Government has also accepted the invitation, and a small sum has been voted by the Storthing.

AT a recent meeting of the Smoke Abatement Committee, held at 44, Berners Street, Mr. Ernest Hart in the chair, jurors' reports were handed in from Col. Festing, C.B., Prof. Chandler Roberts, F.R.S., Mr. Atchison, Mr. D. Kinnear Clark, Mr. Harris, and others, on behalf of the various juries, discussing the results obtained and tabulating the figures shown by the various tests. Great satisfaction was expressed at the excellent results which these reports show to have been achieved by some of the leading exhibits in the economy of fuel and abatement of smoke in open grates, as well as the satisfactory action of open grates and kitcheners intended for burning anthracite or smokeless coal. The hon. secretary (Mr. W. R. E. Coles) announced that the Manchester Exhibition of Smoke-Abating Apparatus, carried out partly under the auspices of this Society, had proved highly successful, and had attracted great interest among the practical men in the Lancashire district, and would, it was believed, be fruitful in good results. The arrangements were discussed for converting this committee into a permanent institution for smoke abatement, under the provisions of the law. It was announced that the Duke of Westminster would preside at a meeting to be held at Grosvenor House on Friday, July 14, for the purpose of distributing the awards, when it was expected that all the reports and tabulations would be ready in the form of a volume for public information.

THE President of the Italian Antarctic Expedition has received, at Genoa, a letter from Lieut. Bove, announcing the arrival of the expedition at Punta Arenas, on April 24 from Staten Island. Staten Island has been thoroughly examined as to its fauna, flora, topography, hydrography, and commercial utility.

THE *Hope*, commanded by Sir Allen Young, left the Thames last week to search for and succour the *Eira*, under Mr. Leigh Smith, missing in the Arctic regions for about a year. The *Hope* is 450 tons register, is fortified for ice work, well equipped, and with provisions for two years, and a year's supply for the *Eira*. Sir Allen, while he will doubtless use his discretion, has been instructed to avoid entering the ice, if possible. It has certainly been a peculiar Arctic season, so far as ice condition are concerned, and Sir Allen may find when he gets on the ground that all his calculations and arrangements are at fault.

MR. C. HOLCOTT BROOKS, Secretary of the Californian Academy of Sciences, sends us the following note on a meteor in Wyoming, which he states is "well authenticated in all respects." "May 11, at 4 p.m., in Weber Cañon, Wyoming Territory, while the sun was shining brightly, a sudden and steady glow in the sky attracted attention to an immense meteor, whose brilliant colours were beautiful beyond description. Its track across the heavens was marked by a large red belt, which after its brightness had died out, left a column of clearly defined white smoke in its place. It fell in a south-easterly direction, and was observed by a scientist who recently arrived in this city, and who attended the meeting of the California Academy of Sciences last evening."

NEW seismic apparatus for indication of earthquake-motions on Etna have been devised by the brothers Brassart, at the instance of Prof. Tacchini. From an illustrated account in the *Rivista Scientifica Industriale*, we gather that the indicator for undulatory shocks is in form as follows: a funnel grooved interiorly (and looking like a small inverted umbrella) is fixed at one end of a pivoted horizontal bar having a counterpoise; it has an aperture at the bottom, which allows of its oscillating a little way with the bar on a vertical column, on which is placed a vertical style with weight at top (this latter act being facilitated by a sliding brass tube). This weight, by its fall (contrary to the direction whence the shock comes), into one of the eight lettered grooves of the funnel (N, E, &c.), indicates the direction, and, depressing the bar, closes a circuit, making an electro-magnet, the result being that the pendulum of a small clock on the base-board is liberated. Thus if the clock had been set at 12, and it indicated 5 when looked at, this would show that the liberating shock had occurred five hours before. An electric bell may be introduced; also the liberation of the pendulum may be effected without electricity. In an arrangement for vertical shocks, a spiral of fine wire, with platina-tipped weight, is suspended vertically over a cup of mercury;

the circuit being closed when the weight dips in the mercury, with effects as above.

The Société Nationale d'Acclimatation de France, at its Annual General Meeting, lately held in Paris, awarded a medal of the first class to Mr. J. E. Harting, F.L.S., for his monograph on "Ostriches," and his recently-published work on "Extinct British Animals."

We are glad to learn that the Geographical Society have finally resolved to make further use of the services of Mr. Joseph Thomson in the work of African exploration. The region to be explored by Mr. Thomson is that around Mount Kilimanjaro, about which our knowledge is so meagre. Mr. Thomson will set out in the beginning of next year.

We have received a copy of an interesting address by Prof. F. W. Hutton of Canterbury College, New Zealand, on "Biology in an Arts Curriculum." The author takes as his subject the principle of selection, and after briefly explaining its importance in biology, proceeds to argue that it is of not less importance in psychology and sociology. The analogues, or rather parallels, which he draws are thoughtful and interesting, as the following examples will show:—"Either from transmission, or from early association, every man has a number of opinions common to the nation and to the class in life to which he belongs, which may be called his inherited opinions; but as his reasoning powers develop, these opinions are subject to variation. The variations may be owing to original ideas arising in his mind we know not how, like the variations of structure in animals; or they may be due to education, that is, to coming into contact with other minds, either personally or through books; and it must be noticed that, unlike structural variations, these mental variations may be produced at any time in a man's life, and may or may not remain constant. Physical transmission is not necessary; mental transmission from mind to mind diffuses a variation rapidly through all the individuals, and consequently it is not necessary for the action of selection that the originator of an improved mental variation should have any bodily offspring. When mental variations compete with one another, selection constantly acts on them through the agency either of utility or of sympathy." Similarly in Sociology Prof. Hutton shows that the principle of selection is all-important, and therefore that the political constitution which best admits of variation within due limits, or is most flexible, is most likely to survive in a struggle with other political constitutions. Hence, he maintains, the growing tendency of Monarchies to supplant Despotisms, and of Republics to supplant Monarchies; also of the progress of parliamentary forms of government—parliamentary discussion being but the principle of selection applied to political ideas. The parallels thus drawn between the principle of selection in biology and its operation in psychology and sociology, are well presented; but they are clearly in no way closely analogous to the survival of the fittest among organisms. There is just such a resemblance as there is in the case to which Prof. Hutton alludes of the analogy between the biological and the social organism, and which, as he truly observes, is incomplete and apt to be misleading. "Indeed, it would not be difficult to find in this analogy as many discrepancies as likenesses. What, for instance, in the organisation of an animal answers to the professors of theology, medicine, or law? What to prisons and reformatories?" &c. So, we think, in the principle of selection, although there is a general resemblance in its operation in biology and in psychology or sociology, the resemblance is nevertheless only general, and may not be pressed too far. Thus, the single fact noticed by the author that variations of ideas may propagate themselves without the aid of heredity, is alone sufficient to constitute an immense difference between the two classes of cases—the biological and the sociological—and it is further evident that in biology there is nothing corresponding to individual judgment, which is the most important agent in selecting variations of ideas.

In the current number of the *Journal of Forestry* is an excellent article on Epping Forest, in which the natural beauties of this well-known resort are faithfully portrayed. It is to be hoped that in the discussion that has raged and is still raging as to the management of Epping Forest under its new superintendent, the aim of Parliament for its preservation "in its natural aspect as a forest" will not be lost sight of. In the words of the writer of a paragraph on the subject in the same number of the *Journal of Forestry*, we repeat that "it is a forest that the public want, and not a gigantic park or tea garden."

It is well known that of late a good deal of attention has been devoted in America to the manufacture of sugar from the Sorghum. In connection with this subject a letter has recently been published in the *New York Daily Tribune* from Prof. Silliman, in which he gives a detailed account of the value of the most important varieties. There seems to be a great future in America for the Sorghum as a sugar producer.

The discussion of diurnal ranges of temperature having shown to Dr. Woeikof (*Izvestia* of the Moscow Society of Naturalists for 1881) how much they depend upon the topographical conditions of different stations, he discusses in the last number of the *Journal* of the Russian Chemical and Physical Society the influence of the same conditions on the average temperatures of winter and on the deviation from average temperatures, especially during anti-cyclones. Comparing the observations at different Swiss stations, he finds that the annual range of temperatures does not always diminish with the height of the station; it is less on isolated mountains, but it is greater in high valleys when they are wide. Discussing further the differences of temperature in valleys and on isolated mountains, he shows how the temperature of the air in the former is often much colder than on the mountains, as well in Switzerland as on the Caucasus, and in Eastern Siberia; and he concludes that the map of isotherms, recently published by Dr. Wild in his great work "On the Temperatures in the Russian Empire," does not give a true idea of the distribution of winter-temperatures, especially in Siberia; most of the stations of this country being situated in valleys, where the temperature is lowered during the winter by typographical conditions, the isotherms for January occupy altogether a too southern position on this map. Thus, for instance, the January isotherm of – 31° which passes through the Voznesensky gold-mine, is lower by 7°·2 than the true temperature for this place, and by 10°·1 if the necessary reduction to the sea-level be taken into account.

On the 14th inst., at 2 p.m., a severe earthquake was felt at the town of Luleå in Sweden (65° 40′ N., 22° 7′ E.). The shocks, which were several, were felt within a radius of thirty-six miles, doors being thrown open, flower-pots turned over, &c., through the tremor of the earth.

M. Brazza has delivered in the large hall of the Sorbonne a lecture on his discoveries in the Ogowe, and his efforts to establish a regular communication between the Ogowe and Congo through a land district. These efforts have proved successful.

The frequent observations of the mirage in the south and central part of Sweden is very remarkable. From time to time we are told that whole landscapes, cities, and castles, with moving objects, have been observed reflected on the sky for hours, and we again learn that a similar display of the forces of Nature was seen one afternoon last month over the lake of Orsa, in a remote part of Dalcarlia, lat. 61°, which is stated to have reflected a number of large and small steamers, as if plying on the lake, and from whose funnels even the smoke could be observed to rise. Later on the scene changed to a landscape, the vessels now taking the form of islands in the lake, covered with more or less vegetation, and at last the mirage dissolved itself in a haze. The phenomenon, which lasted from 4 to 7 o'clock p.m., is said to have furnished a most magnificent spectacle.

THE additions to the Zoological Society's Gardens during the past week include a Yellow Baboon (*Cynocephalus babouin* ♀) from West Africa, presented by Mr. A. Collison; a Slender Loris (*Loris gracilis* ♂) from Ceylon, presented by Mrs. A. H. Jamrach; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. E. Meek; a Burmese Tortoise (*Testudo elongata*) from the Western Dooars of Bhotan, presented by Mr. B. H. Carew; a —— Tree Snake (*Ahætulla liocercus*) from Pernambuco, presented by Mr. C. A. Craven; a Common Adder (*Vipera berus*), British, presented by Mr. F. W. Elliott; a Rude Fox (*Canis rudis*), a Common Rhea (*Rhea americana*) from South America, deposited; a Yellow Baboon (*Cynocephalus babouin*) from West Africa, received on approval; a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens, eight Summer Ducks (*Aix sponsa*), six Swinhoe's Pheasants (*Euplocamus swinhoii*), bred in the Gardens. The following insects having emerged during the past week:—Silk Moths: *Actias selene, Samia cecropia, Attacus mylitta*; Moths: *Hypochera io, Deilephila euphorbiæ, Deilephila vespertilis, Trochilium apiformis, Sciapteron tabaniformis, Sesia muscæiformis, Callimorpha dominula*; Butterflies: *Apatura iris, Vanessa xanthomelas, Vanessa urticæ, Aporia crabægi.*

OUR ASTRONOMICAL COLUMN

MASKELYNE'S VALUE OF THE SOLAR PARALLAX.—Mr. Dunkin has consulted the first edition of Vince's "System of Astronomy," published in 1797, and finds therein Maskelyne's article on a new method of determining the solar parallax, the same as in the second edition which appeared in 1814.

Mr. W. J. Davies, writing from Tyglyn, Cilian Aeron, Cardigan, asks, with reference to this value of the parallax, Is it not probable that this was first published in the *Philosophical Transactions?* Prof. Ball, in his "Elements of Astronomy" (Longmans, 1880), page 361, gives the value $8''{\cdot}723$, and the authority for it, viz., *Phil. Trans.*, vol. lxi. p. 574, year 1771. On this point we may remark that Prof. Ball, according to the statement in his preface, has mainly relied for his numerical data upon Houzeau's "Répertoire des Constantes Astronomiques"—a work which, though excellently designed, would, according to our experience of it, benefit by a careful revision. There are a number of errors in the first edition, which are likely to be copied into more popular works, unless attention be drawn to them. In the present case, where reference is made for Maskelyne's parallax to the *Phil. Trans.*, 1771, p. 574, we find at that page a paper by Dr. Hornsby, entitled "The Quantity of the Sun's Parallax as deduced from the Observation of the Transit of Venus, on June 3, 1769, by Thomas Hornsby, M.A., Savilian Professor of Astronomy in the University of Oxford, and F.R.S.," in which the parallax from a number of combinations is found to be $8''{\cdot}78$. Maskelyne's name is not mentioned in the paper, which appears to relate exclusively to Hornsby's own deductions.

Mr. Dunkin having traced the publication of Maskelyne's note to 1797, the only earlier work of Vince in which it would be likely to be found, is the first edition of his text-book, the "Elements of Astronomy," 1790. Mr. Davies remarks that Olinthus Gregory, in his "Treatise on Astronomy," published in 1803, refers to Maskelyne's method, and considered it the best that had been given; he explains it almost in the same words as in Vince, adding that the assumed value $8''{\cdot}83$ was taken "agreeably to the result of observations on the transit in 1761."

THE COMET OF MAY 17.—M. Trépied, in an account of his observations made in Egypt during the total solar eclipse of May 17, which was communicated to the Academy of Sciences on the 19th inst., has the following interesting note:—"Vers le milieu de la totalité, j'aperçus à droite du Soleil, par un angle zénith de environ 90°, un trait légèrement courbé vers le bas, d'un effet singulier, et en discordance évidente avec le reste de la couronne. Je n'ai pas eu un seul instant l'idée que ce pouvait être une comète; je n'en ai reconnu la nature qu' une heure après l'eclipse, en comparant mon croquis à l'une des photographies obtenues par le Dr. Schuster. Cette photographie montrait nettement le noyau à une distance du bord du Soleil un peu supérieure au diamètre de cet astre; l'angle zénith et la direction de la queue s'accordaient bien avec ce que j'avais dessiné, mais j'avais arrêté le trait à une distance beaucoup trop faible du bord. Je n'ai pas cru cependant qu'il me fût permis de rien changer à mon dessin." The sketch referred to is copied in the *Comptes rendus* of the above sitting of the Academy. M. Trepied further remarks: "L'eclat de la comète m'a paru du même ordre que celui des parties extérieures de la couronne." The position of the observing station, as provisionally determined by M. Trépied, is in longitude 1h. 57m. 40s. east of Paris, and latitude 26° 33′ 21″, where the middle of totality occurred at 8h. 31m. 53s. a.m. local mean time. M. Trépied says in the week following the eclipse he searched for the comet many times before sunrise and after sunset, but without detecting it.

The comet has doubtless been sought for elsewhere, though unfortunately without success. The object notified as having become visible some ten days since in the Cape Colony, near the sun in the evenings, would be the comet 1882 *a* (Wells), March 17).

DAYLIGHT OBSERVATION OF COMET 1882 *a*.—Prof. Julius Schmidt writes to the *Astronomische Nachrichten* that on June 10 after 3 p.m., in an exceptionally clear sky at Athens, he observed the comet, though with difficulty, in the 6-feet refractor of that observatory. By ten observations (the instrumental corrections from previous determination) the approximate position was found to be—

June 10, at $3^{\text{h.}}\ 59^{\text{m.}}{\cdot}7$ M.T. Athens, R.A. $5^{\text{h.}}\ 0^{\text{m.}}\ 40^{\text{s.}}$, Decl. $+23^{\circ}\ 19'{\cdot}4$.

This place differs from that inferred from the last orbit given in this column (on observations to May 21) by $-5'{\cdot}5$ in R.A. and $+3'.2$ in declination. The comet's distance from the nearest limb of the sun was about $2^{\circ}{\cdot}8$.

PHYSICAL NOTES

PROFESSORS BELLATI AND NACCARI, of the University of Padua, have recently sent to the Academy of Sciences at Turin, a memoir on the heat developed in solid and liquid dielectrics by successive electrostatic polarisations. They find that when a dielectric, placed between two metal armatures, is subjected to successive polarisations by means of a Ruhmkorff's coil, the dielectric is warmed. This result had already been obtained by Siemens and Righi in the case of glass; the authors of the memoir have experimented also on liquid dielectrics. They have employed two methods: in one of these the heating was indicated by the dilatation of the liquid dielectric (or, in the case of a solid dielectric, of another liquid) observed in a capillary tube. In the other method, the liquid dielectric was contained in a glass vessel, in which were two concentric metallic cylinders serving as the armatures of a condenser. The outer one of these two cylinders was open above and below; the other was closed, and communicated with a horizontal capillary tube containing benzine. This cylinder, therefore, acted as the bulb of an air-thermometer, the heating of the dielectric being indicated by the displacement of the benzine in the capillary tube. This phenomenon must not be confounded with the electric expansion discovered by Fontana more than a century ago, and more recently studied by Govi, Duter, and Quincke. The true electric expansion is instantaneous, and ceases when the polarisation ceases; but the expansion due to the heat developed in the dielectric by repeated charges and discharges is progressive, and increases by prolonging the action of the induction coil. Professors Bellati and Naccari found no electrolytic decomposition in the dielectric, nor was the heating due to the passage of a feeble current through the dielectric.

THE utilisation of the earth's internal heat is a subject which is attracting the attention of scientific men in Japan just now. At a recent meeting of the Seismological Society, Mr. Milne introduced the subject for the consideration of the members. He first drew attention to the fact that philosophers have told us the whole available energy upon the surface of the earth had in some way or other its action and its existence traceable to the sun. That there was an unlimited supply of energy in the interior of the earth was a circumstance which had, he said, been overlooked. In speaking of this energy, Mr. Milne first referred to that portion of it which crops out upon the surface in countries like Japan, Iceland, and New Zealand, in the form of hot springs, solfataras, volcanoes, &c. He stated that there was an unlimited supply of water in hot springs within a radius of one hundred miles around Tokio, and that the heat of these springs could be converted into an electric current, and the energy transmitted to the town. The second part of the paper referred to the possibility of obtaining access to the heat which did not crop out in the surface.

THE whole behaviour of homogeneous colours is explained (according to Herr Albert, *Wied. Ann.*, No. 5), on the Young-Helmholtz theory, by this assumption: To a lessening of the intensity of vari-coloured light correspond various lessening of the strength of sensation, such that for rays of less wave-length, to whatever part of the spectrum they belong, it decreases more slowly than for rays of greater wave-length.

GEOGRAPHY IN RUSSIA

THE just issued "Annual Report of the Russian Geographical Society for 1881" shows that during last year the Society has again accomplished a good deal of useful scientific work. A subject to which much attention was given was the establishment of polar meteorological stations. The station at Novaya Zemlya has already been in operation, as is known, for two years, and a new one, which will be established at the mouth of the Lena, is provided with the best instruments, and is intrusted to persons who will be able to make of it a first-class meteorological observatory. During the summer the expedition will reach the shores of the Arctic Ocean, and begin the meteorological observations. The Dutch station will be erected at Port Dickson, at the mouth of the Yenisei.

Among the scientific expeditions undertaken by the Society, that of M. Polakoff, to Sakhalin, promises to give very interesting results. The rich ornithological collections made in the Alexandrovsk Valley, on the western coast, proved that the birds of Western Sakhalin have a remarkable likeness with those of Siberia and Northern Russia. The same is true with regard to the former inhabitants of Sakhalin, whose stone implements and remains of earthenware, discovered in great masses, are much like, or even identical to, those of European Russia; the presence of obsidian implements, however, originally from Kamschatka, or from the islands of the Pacific, hints that the inhabitants were in intercourse with these countries. M. Polakkoff has also discovered dwellings of the same period, which were holes, like those of the Kamtchadales, the numerous stone pieces which were used to be attached to the nets, show that the nets of the prehistoric man were very large, and that fishing was carried on to a great extent at that period.

The result of M. Polakoff's explorations of the eastern shores of the island, as well as in its middle parts, are not yet known. M. Adrianoff's journey in very little known parts of the Tormsk and Sayan Mountains, during which the explorer crossed Lake Teletzekoye and the Shapshal Mountains, have given rich materials for the geology, zoology, and botany of these countries. The travels of A. E. Regel to the Pamir, M. Hedroitz's explorations of the alluvial deposits of the Amu-daria, M. Lessar's travel to Saraks, and M. Moushketoff's researches on Caucasus, have already been mentioned in NATURE.

A very interesting journey, mentioned in the "Report," was made by A. W. Eliseeff, who tried to follow the same route to Palestine which was followed by the Jews during their exode from Egypt. M. Eliseeff discovered during the journey numerous traces of man of the Palæolithic and of the Neolithic periods in Arabia Petrea, as well as in Egypt and in Palestine. The prehistoric man of the Sinai peninsula belonged to two different types: one, with light bones, of the Semitic type, and the other, with massive bones, of the Berber type; dolichocephalic skulls are predominant. Both had the custom of burning corpses, and did not neglect anthropophagy; however, their chief food consisted of wild animals, fishes, and molluscs. The disposition of these remains confirms the hypothesis of Owen, that the Sinai peninsular and lower Egypt were under water, excepting the higher terraces, after man inhabited the banks of the Nile. As to the present inhabitants, the Arabs of the peninsula afford two different types: a western one, more akin to the Fellah and Egyptian type, and the eastern one, which is of a purer Arabian origin. The nomad Bedouins belong to different sub-types, and there are in the Bedouin desert, traces of a fair-haired people, as well as representatives of Berberian and Ethiopian blood. Some very interesting material for a knowledge of prehistoric man was also discovered by M. W. Malakhoff, during his journey on the western slopes of the Middle Ural. The remains of this epoch are very numerous, especially on the shores of lakes, and they are the more interesting, as we find here the first vestiges of an epoch when the Neolithic man began to discover the properties of metals, and to manufacture metallic implements from the rich ores he found on the Ural. The skeletons of men of this period discovered, together with mixed implements of stone, bone, and copper, are most interesting, especially with regard to the skulls, which represent a very low stage of human development. The remains of a later epoch (implements and rock hieroglyphics) are also very numerous. M. Malakhoff concluded his researches by ethnographical observations on the present Permyaks, whom he considers as very nearly akin to the primary prehistoric inhabitants of this region. G. N. Potanin's exploration of the Votyaks, of their migrations, mythology, and customs, and an excursion of S. K. Kouznetzoff to the Tcherenisses of the Vyatka government promises to yield interesting results.

Among the new publications of the Society we notice the following:—The Anthropology of Mordvinians, by W. N. Mainoff, is printing, and will appear in the eleventh volume of the Ethnographical Memoirs of the Society; the anthropological researches of K. S. Mereshkovsky in the Crimea, preliminary reports of which have appeared in the *Izvestia*, will soon be ready to print; G. N. Potanin's work, "Sketches of North-Western Mongolia," being a report, in two volumes, of his first journey in Mongolia, is an important acquisition for the geography of Asia; the first volume contains abundance of valuable geographical information, and the second contains the ethnographical results, with twenty-six tables of drawings. Volumes iii. and iv. of this work, the third already being under press, will contain the results of the second journey of M. Potanin in Mongolia; the work of N. M. Przhevalsky, "Travels in the Deserts of Central Asia" will consist of six volumes, with more than 120 drawings and maps, four volumes being devoted to the zoology, botany, and geology of these countries; the first volume is already finished by the author, as well as several parts of the following volumes:—An interesting map of Jungaria, drawn up by the Swedish Lieutenant Renat in the eighteenth century, after several months' imprisonment by Kalmuks, was published last year by A. S. Maksheef. Finally, the "Report" mentions also a series of pamphlets, in French, published for the Geographical Exhibition at Venice, which contains very good reviews of scientific work done in Russia in hydrography, zoo-geography, botanical geography, geology, and statistics during the last five years.

The ninth volume of the Memoirs of the Society for the Physico-Geographical Section contains an excellent work by A. W. Kaulbars on the delta of the Amu-daria—unhappily without the atlas of maps and drawings, which the Society was unable to publish. The tenth volume will contain the materials collected by the expedition of Karelin in 1830, which are not yet published.

PRELIMINARY NOTICE OF THE RESULTS ACCOMPLISHED IN THE MANUFACTURE AND THEORY OF GRATINGS FOR OPTICAL PURPOSES[1]

IT is not many years since physicists considered that a spectroscope constructed of a large number of prisms was the best and only instrument for viewing the spectrum, where great power was required. These instruments were large and expensive, so that few physicists could possess them. Prof. Young was the first to discover that some of the gratings of Mr. Rutherfurd showed more than any prism spectroscope which had then been constructed. But all the gratings which had been made up to that time were quite small, say 1 inch square, whereas the power of a grating in resolving the line of the spectrum increases with the size. Mr. Rutherfurd then attempted to make as large gratings as his machine would allow,

---

[1] By Prof. H. A. Rowland. (Extract from Johns Hopkins University Circular, No. 16.) Communicated by the Author.

and produced some which were nearly 2 inches square, though he was rarely successful above 1¾ inches, having about 30,000 lines. These gratings were on speculum metal, and showed more of the spectrum than had ever before been seen, and have, in the hands of Young, Rutherfurd, Lockyer, and others, done much good work for science. Many mechanics in this country, and in France and Germany, have sought to equal Mr. Rutherfurd's gratings, but without success.

Under these circumstances, I have taken up the subject with the resources at command in the physical laboratory of the Johns Hopkins University.

One of the problems to be solved in making a machine is to make a perfect screw, and this, mechanics of all countries have sought to do for over a hundred years and have failed. On thinking over the matter, I devised a plan whose details I shall soon publish, by which I hope to make a practically perfect screw, and so important did the problem seem, that I immediately set Mr. Schneider, the instrument maker of the university, at work at one. The operation seemed so successful, that I immediately designed the remainder of the machine, and have now had the pleasure since Christmas of trying it. The screw is practically perfect, not by accident, but because of the new process for making it, and I have not yet been able to detect an error so great as 1·100,000th part of an inch at any part. Neither has it any appreciable periodic error. By means of this machine I have been able to make gratings with 43,000 lines to the inch, and have made a ruled surface with 160,000 lines on it, having about 29,000 lines to the inch. The capacity of the machine is to rule a surface 6¼ × 4¼ inches, with any required number of lines to the inch, the number only being limited by the wear of the diamond. The machine can be set to almost any number of lines to the inch, but I have not hitherto attempted more than 43,000 lines to the inch. It ruled so perfectly at this figure that I see no reason to doubt that at least two or three times that number might be ruled in one inch, though it would be useless for making gratings.

All gratings hitherto made have been ruled on flat surfaces. Such gratings require a pair of telescopes for viewing the spectrum; these telescopes interfere with many experiments, absorbing the extremities of the spectrum strongly; besides, two telescopes of sufficient size to use with 6-inch gratings would be very expensive and clumsy affairs. In thinking over what would happen were the grating ruled on a surface not flat, I thought of a new method of attacking the problem, and soon found that if the lines were ruled on a spherical surface, the spectrum would be brought to a focus without any telescope. This discovery of concave gratings is important for many physical investigations, such as the photographing of the spectrum both in the ultra-violet and the ultra-red, the determination of the heating effect of the different rays, and the determination of the relative wave-lengths of the lines of the spectrum. Furthermore, it reduces the spectroscope to its simplest proportions, so that spectroscopes of the highest power may be made at a cost which can place them in the hands of all observers. With one of my new concave gratings I have been able to detect double lines in the spectrum which were never before seen.

The laws of the concave grating are very beautiful, on account of their simplicity, especially in the case where it will be used most. Draw the radius of curvature of the mirror to the centre of the mirror, and from its central point with a radius equal to half the radius of curvature draw a circle; this circle thus passes through the centre of curvature of the mirror, and touches the mirror at its centre. Now if the source of light is anywhere in this circle, the image of this source and the different orders of the spectra are all brought to focus on this circle. The word focus is hardly applicable to the case, however, for if the source of light is a point, the light is not brought to a single point on the circle, but is drawn out into a straight line with its length parallel to the axis of the circle. As the object is to see lines in the spectrum only, this fact is of little consequence, provided the slit, which is the source of light, is parallel to the axis of the circle. Indeed, it adds to the beauty of the spectra, as the horizontal lines due to dust in the slit are never present, as the dust has a different focal length from the lines of the spectrum. This action of the concave grating, however, somewhat impairs the light, especially of the higher orders, but the introduction of a cylindrical lens greatly obviates this inconvenience.

The beautiful simplicity of the fact that the line of foci of the different orders of the spectra are on the circle described above, leads immediately to a mechanical contrivance by which we can move from one spectrum to the next, and yet have the apparatus always in focus; for we have only to attach the slit, the eye-piece, and the grating to three arms of equal length, which are pivoted together at their other ends, and the conditions are satisfied. However we move the three arms, the spectra are always in focus. The most interesting case of this contrivance is when the bars carrying the eye-piece and grating are attached end to end, thus forming a diameter of the circle with the eye-piece at the centre of curvature of the mirror, and the rod carrying the slit alone movable. In this case the spectrum as viewed by the eye-piece is normal, and when a micrometer is used, the value of a division of its head in wave-lengths does not depend on the position of the slit, but is simply proportional to the order of the spectrum, so that it need be determined once only. Furthermore, if the eye-piece is replaced by a photographic camera, the photographic spectrum is a normal one. The mechanical means of keeping the focus is especially important when investigating the ultra-violet and ultra-red portions of the solar spectrum.

Another important property of the concave grating is that all the superimposed spectra are in exactly the same focus. When viewing such superimposed spectra it is a most beautiful sight to see the lines appear coloured on a nearly white ground. By micrometric measurement of such superimposed spectra we have a most beautiful method of determining the relative wave-lengths of the different portions of the spectrum, which far exceeds in accuracy any other method yet devised. In working in the ultra-violet or ultra-red portions of the spectrum we can also focus on the superimposed spectrum, and so get the focus for the portion experimented on.

The fact that the light has to pass through no glass in the concave grating makes it important in the examination of the extremities of the spectrum where the glass might absorb very much. There is one important research in which the concave grating in its present form does not seem to be of much use, and that is in the examination of the solar protuberances; an instrument can only be used for this purpose in which the dust in the slit and the lines of the spectrum are in focus at once. It might be possible to introduce a cylindrical lens in such a way as to obviate this difficulty. But for other work on the sun the concave grating will be found very useful. But its principal use will be to get the relative wave-lengths of the lines of the spectrum, and so to map the spectrum; to divide lines of the spectrum which are very near together, and so to see as much as possible of the spectrum; to photograph the spectrum so that it shall be normal; to investigate the portions of the spectrum beyond the range of vision; and lastly to put in the hands of any physicist at a moderate cost such a powerful instrument as could only hitherto be purchased by wealthy individuals or institutions.

To give further information of what can be done in the way of gratings I will state the following particulars:—

The dividing engine can rule a space 6¼ inches long, and 4¼ inches wide. The lines, which can be 4¼ inches long, do not depart from a straight line so much as 1-100,000th of an inch, and the carriage moves forward in an equally straight line. The screw is practically perfect, and has been tested to 1-100,000th of an inch, without showing error. Neither does it have any appreciable periodic error, and the periodic error due to the mounting and graduated head can be entirely eliminated by a suitable attachment. For showing the production of ghosts by a periodic error, such an error can be introduced to any reasonable amount. Every grating made by the machine is a good one, dividing the 1474 line with ease, but some are better than others. Rutherfurd's machine only made one in every four good, and only one in a long time which might be called first-class. One division of the head of the screw makes 14,438 lines to the inch. Any fraction of this number in which the numerator is not greater than say 20 or 30 can be ruled. Some exact numbers to the millimetre, such as 400, 800, 1200, &c., can also be ruled. For the finest definition either 14,438 or 28,876 lines to the inch are recommended, the first for ordinary use, and the second for examining the extremities of the spectrum. Extremely brilliant gratings have been made with 43,314 lines to the inch, and there is little difficulty in ruling more if desired. The following show some results obtained:—

Flat grating, 1 inch square, 43,000 lines to the inch. Divides the 1474 line in the first spectrum.

Flat grating, 2 × 3 inches, 14,438 lines to the inch, total 43,314. Divides 1474 in the first spectrum, the E line (Angström 5269·4) in the second, and is good in the fourth and even fifth spectrum.

Flat grating, 2 × 3 inches, 1200 lines to one millimetre. Shows very many more lines in the B and A groups than were ever before seen.

Flat grating, 2 × 3¼ inches, 14,438 lines to the inch. This has most wonderful brilliancy in one of the first spectra, so that I have seen the Z line, wave-length 8420 (see Abney's map of the ultra-red region), and determined its wave length roughly, and have seen much further below the A line than the B line is above the A line. The same may be said of the violet end of the spectrum. But such gratings are only obtained by accident.

Concave grating, 2 × 3 inches, 7 feet radius of curvature, 4818 lines to the inch. The coincidences of the spectra can be observed to the tenth or twelfth spectrum.

Concave grating, 2 × 3 inches, 14,438 lines to the inch, radius of curvature 8 feet. Divides the 1474 line in the first spectrum, the E line in the second, and is good in the third or fourth.

Concave grating, 3 × 5½ inches, 17 feet radius of curvature, 28,876 lines to the inch, and thus nearly 160,000 lines in all. This shows more in the first spectrum than was ever seen before. Divides 1474 and E very widely, and shows the stronger component of Angström 5275 double. Second spectrum not tried.

Concave grating, 4 × 5¾ inches, 3610 lines to the inch, radius of curvature 5 feet 4 inches. This grating was made for Prof. Langley's experiments on the ultra-red portion of the spectrum, and was thus made very bright in the first spectrum. The definition seems to be very fine, notwithstanding the short focus, and divides the 1474 line with ease. But it is difficult to rule so concave a grating, as the diamond marks differently on the different parts of the plate.

These give illustrations of the results accomplished, but of course many other experiments have been made. I have not yet been able to decide whether the definition of the concave grating fully comes up to that of a flat grating, but it evidently does so very nearly.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Cambridge.—The following awards have been made at St. John's College for proficiency in natural science:—Foundation Scholarships to Bateson, Goodman; Exhibitions to Edmunds, Love, T. Roberts (already scholars), and to Acton, Andrews, Clementson. T. Roberts also received a Wright's Prize, with augmentation of scholarship to 100*l.* for the year. In the Open Exhibition Examination at Easter, H. Stroud (Owens College) was awarded a a Foundation Scholarship of 100, and Fuller (Perse School, Cambridge), 50*l.* for three years.

In the long list of lectures on Natural Science for the ensuing academical year, lately published, we note as new courses or features of special interest, Mr. Shaw's lectures on some Applications of the Higher Mathematics to Physics (Michelmas Term); Dr. Roberts's lectures on Physiography (Michaelmas Term); Prof. Hughes's Course of Dynamical Geology (Lent Term); Dr. Vines's complete course of advanced Botanical Study, extending through the year; Prof. Newton's lectures on the Evidence of Evolution in the Animal Kingdom, in the Michaelmas Term, and on the Geographical Distribution of Animals, in the Easter Term; and Prof. Balfour's announcement of his lectures and practical work, as Professor of Animal Morphology.

The annual report of the Botanic Gardens Syndicate details work done in improving the Gardens, and amongst valuable additions to the collection, the Tonga plant, recently introduced from the Fiji Islands. A special collection of medical plants has been formed, which already contains the most important hardy plants, and some of considerable rarity. About 8000 labels have been written during the year.

With regard to the recent Mathematical Tripos (in which Messrs. Welsh of Jesus College, and Turner of Trinity College, were respectively Senior and Second Wranglers), although the twenty-nine Wranglers may enter for a further advanced examination in January next, they are by no means compelled to do so. The examination, so far as it has already proceeded, includes very many of the subjects of the old Mathematical Tripos, and we anticipate that unless the colleges decline to elect to Fellowships Wranglers who do not proceed to the higher examination, many will rest content with the test already undergone. The recent talk about the "abolition of the Senior Wrangler" has not a very valid basis.

The eighth annual meeting of the Yorkshire College was held at Leeds on Saturday, Sir Edward Baines in the chair. Prof. Marshall, the principal, made a satisfactory report, and a resolution of the council was confirmed to proceed with the completion of the new college buildings. On the proposition of the Mayor of Leeds (Alderman Tatham) it was resolved that, in memory of the late Lord F. Cavendish, M.P., the late president of the college, who for twelve years had been one of its foremost promoters, a fund be established for the endowment ot a Cavendish Professorship of Physics or for such other purpose as the council should deem best.

SCIENTIFIC SERIALS

Notes from the Leyden Museum, vol. iv. No. 2, April, 1882, contain: On American Diptera, by F. M. van der Wulf.—On new species of Lycidæ, Lampyridæ, and Telephoridæ, and on a new Sumatran species of Callimerus, by Rev. H. S. Gorham.—On new species of Pedilidæ and Anthicidæ, and on a new African species of Hister, by S. de Marseul.—On the Holothurians in the Leyden Museum, by Dr. H. Ludwig.—On some British Indian reptiles and amphibia, by Dr. A. Hubrecht.—On the Pselaphidæ and Scydmænidæ of the Sunda Islands by Dr. L. W. Schaufuss.—Description of a new species of Apogonia, by Dr. D. Sharp.—On a new species of Pantolamprus from Liberia, by Dr. E. Candèze.

Bulletin de la Soc. Imp. des Naturalistes de Moscou, tome lvi. No. 3, 1882, contains; V. Kiprijanoff, on fish remains in the Siwerischen Osteoliths (2 plates).—Dr. Max Schmidt, on *Bolborhynchus monachus.*—Prof. K. Lindeman, on *Coleophora tritici*, a new injurious Russian insect.—Dr. J. v. Bedriaga.—On the Amphibia and Reptiles of Greenland.—F. v. Thumen, contributions to the fungal-flora of Siberia.—N. Vischniakoff, on the *Ammonites distractus* of Quensted.—Prof. Bredichen, report on the tails of comets 1881 *b* and *c*.—Dr. E. Kern, on a new milk ferment from the Caucasus (2 plates).—Th. A. Sludski, on two inequalities taking place in the movement of the solar system (in Russian).—A. Becker, journey to Southern Daguestan.—M. Menzbier, comparative review of the ornithological fauna of Moscow and Toula.—A. Regel, Correspondence.

Zeitschrift für wissenschaftliche Zoologie, vol. xxxvi., part 4, 1882, contains J. Brock, on the anatomy and systematic position of the Cephalopoda (with plates 34 to 37).—O. Katz, contribution to a knowledge of the tegumentary system of the pouch and its several accompanying organs in the marsupials (with plates 38-40).—R. Rössler, contribution to the anatomy of the Phalangidæ (with plates 41 and 42).

Archives des Sciences Physiques et Naturelles, May 15.—Study on the chemical composition of albuminoid substances (continued), by A. Danilewsky.—Mean diurnal heights of Lake Leman, at Secheron, from 1874 to 1881, by P. Plantamour.—The rheolyser, by E. Hartmann.—Darwin considered as regards the causes of his success and the importance of his works, by Alph. de Candolle.

Sitzungsberichte und Abhandlungen der naturwissenschaftlichen Gesellschaft Isis in Dresden, July to December, 1881.—On some lime-spar crystals, by A. Pungold.—Flora of Dresden and its environs, by C. F. Schulze.—On the oldest traces of fossil plants in Saxony, by H. B. Geinitz.—On the progress of Geological researches in North America, by the same.—On the occurrence of Cenomanian petrefactions at Dohne, by J. v. Deichmüller. On the occurrence of the Riesengebirge races of *Pinus Montana*, Müll., in the Saxon-Bohemian Oberlausitz, by O. Drude.

SOCIETIES AND ACADEMIES

London

Royal Society, June 15.—"On an Arrangement of the Electric Arc for the Study of the Radiation of Vapours, together with the Preliminary Results." By Professors Liveing and Dewar.

By the arrangement described, the authors are able to make observations as the temperature rises and as it falls, and so to trace the influence of temperature in many cases in which the extent of that influence was before doubtful. The temperature attainable is doubtless far below that of the arc, but still it is quite sufficient to maintain iron and aluminium in the state of vapour, and show the reversal of the lines of these elements with singular sharpness. The temperature of the interior is sufficiently high to transform the diamond into coke, even in a current of hydrogen, and the result may be taken as proving that the temperature is above that of the oxyhydrogen flame.

The apparatus is thus constructed:—A rod of carbon, 15 millims. in diameter, perforated down its axis with a cylindrical hole 4 millims. in diameter, is passed through a hole in a lime block, and is connected with the positive electrode of a Siemens' dynamo electric machine; another carbon rod, unperforated, is passed into the lime block through a second hole at right angles to the first, so that its end meets the middle of the other rod inside the block of lime. The second rod is connected with the negative electrode of the dynamo-machine, and after contact is made between the two rods, is raised a little, so that the arc discharge continues between the two carbon rods within the block of lime. In this way, the outside of the perforated rod or tube becomes intensely heated, the heat is retained by the jacket of lime, and the interior of the tube gradually rises in temperature, and attains in the central part a very high point. By stopping the arc it can be made to pass through the same stages of temperature in the inverse order. Observations are made by looking down the perforation. When the light issuing from the tube is projected by a lens on to the slit of a spectroscope, the heated walls of the tube give at top and bottom a continuous spectrum, against which various metallic lines are seen reversed, while in the central part, when the tube is open at the further end, the spectrum is discontinuous, and the metallic lines seen reversed against the walls at top and bottom, appear as bright lines.

By passing a small rod of carbon into the perforation from the further end, a luminous background can be obtained all across the field, and then, as the walls of the tube are hotter than the metallic vapours between them and the eye, the metallic lines are only seen reversed. A very slight alteration in the position of the carbon rod makes the lines disappear, or reappear, or show reversal, and as the core is adjusted by eye-observation before photographs are taken, all the conditions of the experiments are thoroughly known and are under easy control. The authors have taken photographs of the violet and lower part of the ultra-violet spectrum given by the tube at successive intervals while the temperature was rising, and noted the following results. When commercial carbons were used the first lines to be seen as the temperature rose were the potassium lines, wave-length 4044-6, next the two aluminium lines between H and K became conspicuous, then the manganese triplet about wave-length 4034, and the calcium line, wave-length 4226, then the calcium lines near M and an iron line, probably M, between them, and then gradually a multitude of lines which seem to be all the conspicuous iron lines between O and *h*. At this stage, when the small rod is used to give a background, the bright continuous spectrum is crossed by a multitude of sharp dark lines, vividly recalling the general appearance of the solar spectrum. In the higher region the continuous spectrum extends beyond the solar spectrum, and the magnesium line, wave-length 2852, is a diffuse dark band, while all the strong iron lines about T, and the aluminium pair near S, are seen as dark lines. The behaviour of the calcium lines H and K is peculiar. These lines are often absent altogether, when the line wave-length 4226 and the two near M are well seen, and when the two aluminium lines between them and many of the iron lines are sharply reversed. Even the introduction of a small quantity of metallic calcium or calcium chloride into the tube did not bring them out reversed. They were only seen as bright lines, not very strong, when the small rod was removed.

In some of the photographs H is visible as a bright line without K. The authors have formerly observed that K shows reversal in the electric arc spectrum taken in a lime crucible on the addition of aluminium, when H remains bright, and such a condition as that shown by the hollow carbon tube when H is present without K, might legitimately have been predicted. The lithium lines at 4603 and 4131 are often bright when many other lines in the neighbourhood are reversed, and must therefore be regarded as relatively difficult of reversal. As a rule, the lines less refrangible than 4226 are balanced as to their emissive and absorptive power and therefore disappear, while the more refrangible are reversed. The cyanogen group at 3883 remain bright when the iron lines on either side are reversed; they often, however, disappear on the continuous spectrum. Many lines about P end Q of the solar spectrum are reversed. The cyanogen band above K is generally to be found in the photographs of the spectrum when only air is in the tube. It is then very faint, and is the only cyanogen group visible. If ammonia is passed into the tube the fine set above K, the N group, and, although less plainly marked, the set at 4218 appear. In one plate the thin lines at 4380 and the group of seven at 4600 appear along with the blue hydrocarbon set. It is well known that ammonia reacts on carbon at a white heat, producing cyanide of ammonium and hydrogen, so that the genesis of the cyanogen spectrum under the present conditions is a crucial test of the validity of the author's former observations on this subject.

Both the indium lines 4101 and 4509 are persistently reversed, together with several lead lines. Tin gives lines partly reversed in highly refrangible portions of the spectrum, and silver gives a fine fluted-looking spectrum in the blue. Chloride of calcium gives a striking set of six or seven bands about M, which may be seen both bright and reversed.

When the small rod is removed, it is easy at any moment to sweep out the vapours in the tube by blowing through it; it is equally easy to pass in reducing or other gases. Ammonia introduced seems to facilitate the appearance of reversed lines. On passing this gas through a tube containing magnesia, the set of lines just below *b*, which the authors have always found to be associated with the presence of magnesium and hydrogen, and is most probably due to some compound, instantly appear. When the authors can command several electric arcs to heat a considerable length of carbon tube, and are enabled to examine the radiation of a powerful arc passing through the vapour in the tube, valuable results may be anticipated.

Linnean Society, June 15.—Sir J. Lubbock, Bart., M.P., F.R.S., in the chair.—The following gentlemen were elected Fellows of the Society:—The Rev. R. Collie, Chas. A. Ferrier, J. D. Gibson-Carmichael, Sir J. R. Gibson-Maitland, Bart., W. D. Gooch, M. Murphy, Rev. H. A. Soames, H. C. Stephens, H. G. W. Stephens, and James Turner.—Mr. W. T. Thiselton Dyer exhibited specimens of *Equisetum giganteum* from Brazil, which is said to have aërial stems attaining 30 feet.—Mr. C. B. Clarke drew attention to a bundle of Hampshire *Orchis*, in support of his view regarding the *O. incarnata*, L.—Mr. H. N. Ridley showed a *Carex glauca* with two pediceled spikes and lower male spike, each arising from a complex utricle; and he also showed a specimen of *Lolium perenne* exemplifying transition from plumes to carpellary leaves.—Mr. G. J. Fookes exhibited and explained peculiarities of malformation in specimens of wallflower and *Clematis lanuginosa*, var. *alba*.—Sir John Kirk gave information concerning specimens of fruit leaves and the rubber of *Landolphia florida* obtained from the island of Pemba, North Zanzibar; and he showed native bells and rubber beaters from East Central Africa, pointing out the beaters were the only application of the rubber made use of by the negroes.—Sir J. D. Hooker read a paper on "*Dyera*," a new genus of rubber-producing plants belonging to the natural order Apocyneæ, from the Malayan Archipelago. The nearest affinity is with *Alstonia*, from which it differs in the sessile stigmas and singular pistils. Its flower is very minute, scarcely 1-8th of an inch long, and ovules of 1-200th of an inch diameter, yet these are succeeded by fruits of immense size.—The next communication was on the caoutchouc-yielding Apocynaceæ of Malaya and Tropical Africa, by W. T. Thiselton Dyer (for which see science notes).—Prof. E. Ray Lankester afterwards read notes on some habits of Scorpions. Of *Androctonus funestris*, Ehr., he referred to their manner of burrowing in the sand, making horizontal tunnels occasionally 8 inches long. The process of exuviation was described, the scorpion then pushing its large chelæ into the sand and scraping rapidly backwards with the three anterior pairs of walking legs. *Androctonus* in walking raises its body well from the ground, and carries the tail and sting arched over the back, thus differing from *Euscorpius*, which keeps the body low, and drags the tail behind, with only the very tip bent. *Androctonus* feeds at dusk, seizing its prey with the left chela, and, swinging the tail overhead, pierces its victim, and, afterwards grasping the body by the short cheliceræ, sucks the nutrient substances. The comb ordinarily is not sensitive, though it may be more so during the breeding season. Specimens of *Euscorpius* fought with each other, then using the chelæ, and not the sting.—Mr. G. Brook read a paper on a new genus of Collembola (*Sinella*), allied to

Degeeria, Nic. The former differs from the latter in possessing four, and not sixteen eyes, in the absence of the long abdominal hairs, and in the different construction of the claws and mucrones.—Mr. McLachlan made a communication on a Marine caddis-fly from New Zealand. Material for examination of this curious discovery having been received by the author from Prof. Hutton of Canterbury, New Zealand, who found larvæ, &c., in rock pools between high and low water-mark in Lyttleton Harbour. The small pupa case is surrounded with and strengthened by portions of a coralline. Mr. McLachlan finds that the caddis-fly in question has been referred to as a new genus, *Philanisus*, by Walker, and apparently the same form described by Brauer under the name of *Anomalostoma*, but neither of these entomologists seem to have known anything regarding the development or habits of the insect.—Prof. P. M. Duncan, in a paper on the genus *Pleurochinus*, L. Agass., now shows that the linking it with the fossil forms from Gand, as described by D'Archiac and Haime, is erroneous. The minute anatomy of its test corresponds closely with that of *Temnopleurus*, with which he places it as a sub-genus; it being distinct from *Temnochinus*, and the Nummulitic so-called Temnopleuridæ of D'Archiac and Haime.—Mr. F. M. Campbell gave his observations on a probable case of parthenogenesis in the house spider (*Tegeneria*). He submits that the fertility of one of the spiders he kept in confinement for 11 months, during which time she twice moulted and afterwards laid eggs, which were duly hatched, can only be explained by one of the two alternatives—(1) either impregnation must have occurred prior to the casting of the two exuviæ, and therefore in an immature stage; or (2) parthenogenesis takes place in the Aracnidea, of which no case (virgin reproduction) has hitherto been recorded in the true spiders.—A paper was read, on the indication of the sense of smell in Actiniæ, by Messrs. W. H. Pollock and G. J. Romanes. From their experiments, it appears probable that a kind of diffused olfactory sense is possessed by these lowly organised creatures.—Thereafter the following papers were read:—On the fungi of Queensland, Australia, by Messrs. M. J. Berkley and C. E. Broome; on a new Infusorian allied to *Pleuronema*, by F. W. Phillips; on *Teredo utriculus*, Gm., and other ship-worms, by S. Hanley; on a collection of ferns from the Solomon Islands, by J. G. Baker; and the fifteenth contribution to the Mollusca of the *Challenger* expedition, by the Rev. R. Boog Watson.—With a few remarks from the President, concluding the session, the meeting adjourned till November 2.

Meteorological Society, June 21.—Mr. J. K. Laughton, F.R.A.S., president, in the chair.—The following papers were read:—A new metal screen for thermometers, by the Rev. F. W. Stow, M.A., F.M.S. This screen differs from the ordinary Stevenson in the following respects:—(1) It is somewhat larger. (2) It has a single set of double zinc louvres. (3) It is partially closed at the bottom to cut off radiation from the ground. The advantages claimed for the use of zinc louvres are:—(1) The conductivity of metal causes the heat derived from the sun's rays to be distributed over every part of the louvres. (2) The louvres being much thinner than those of wood, the circulation of air through the screen is not only much greater absolutely, but much greater also in proportion to the bulk of the louvres. (3) The zinc louvres, therefore, are much more sensitive to changes of temperature than wooden ones. Comparative readings of thermometers in this screen, along with those in an ordinary Stevenson screen, were made during the summer of 1881. From these, the author is of opinion that the Stevenson becomes unduly heated when the sun shines, but this may be as much due to its small size as to the material of which the louvres are made. The thermometers in it are only three to five inches from the louvres at the back of the screen, against seven to eight inches in the zinc screen. The roof, too, is single, and the box is open at the bottom. The author also says that there is no need to condemn all wooden screens, but there does seem to be some reason to think that screens with metal louvres might be better.—On the effect of different kinds of thermometer cribs, and of different exposures in estimating the diurnal range of temperature at the Royal Observatory, Cape of Good Hope, by David Gill, LL.D., F.R.A.S. Meteorological observations were commenced at the Cape Observatory in 1841, when the thermometers were placed in a well-ventilated crib, before a south window, through which they could be read. The buildings were, unfortunately, burnt in 1852. A small wooden house with double roof, and affording a free passage of air, was then erected on the site of the old meteorological observatory. The instruments were placed in the middle of this building, and observations were recommenced on the same plan as before, and continued until the end of August, 1858. On September 1 the thermometers were transferred to a crib erected in front of the south-west window of the transit-circle room. This crib is well ventilated, except on the side next the transit-room window, but the great mass of solid masonry in the immediate neighbourhood of the thermometers appears seriously to affect the range of temperature. For many years a Glaisher stand has been in use, and at the end of 1880 the author caused a Stevenson screen to be erected in its immediate neighbourhood. In this paper the author gives results of observations made in the window, Stevenson and Glaisher screens, during the year 1881, from which it is evident that the exposure of the thermometers in the window crib gives a distinctly smaller, and on the Glaisher stand a larger, daily range of temperature than in the Stevenson screen.—Some account of a cyclone in the Mozambique Channel, January 14–19, 1880, by C. S. Hudson.—Rainfall of Frere Town, Mombassa, East Coast of Africa, 1875–1881, by R. H. Twigg, M.Inst.C.E., F.M.S.

Anthropological Institute, June 13.—General Pitt-Rivers, F.R.S., president, in the chair.—Mr. Mann S. Valentine, of Richmond, Virginia, exhibited a series of figures carved in steatite and mica schist, forming part of a large collection found by him in Virginia and North Carolina. The whole collection consists of some 2000 specimens, consisting of various animals and household utensils, cups, &c.; the human beings are all clothed, and are represented riding on animals and sitting on chairs, and indicating a remarkably advanced state of civilisation; and in some instances, obvious traces of contact with Europeans. Mr. A. H. Keane describ d the district in which the objects had been found, and the tribes that were known to have inhabited that country.—The following papers were read: Nepotism in Travancore, by the Rev. S. Mateer; the Laws of Madagascar, by Dr. W. G. Parker; and Cummer Co., Wexford, by G. H. Kinahan, Esq.

Berlin

Physical Society, June 9.—Prof. Roeber in the chair.—Prof. Neesen described experiments on the relation between specific heat and temperature; and first, in the case of distilled water. In these, he used the method of cooling, and the ice-calorimeter; the manipulation of which he indicated. Each time, after filling the calorimeter, and before the heated substance was introduced, the mercury-column, whose displacement, due to the melting ice, was to be observed, showed spontaneous movements, first back and then forwards; which source of error could be partly avoided by using glass for the external envelope of the calorimeter, instead of the zinc-vessel. It further appeared, that the first two measurements always gave too small values, and were useless, probably because the ice, which was to be melted by the cooling body, was not at 0° C. at the beginning of the experiment, but at a lower temperature, and therefore a part of the communicated heat was used in heating to 0° C. The carefully purified distilled water, whose specific heat was to be ascertained, was in a platinum or glass capsule; in the former the soldering occasioned great difficulties, so that most experiments were made with glass. The measurements already made (they will be extended next winter) range in temperature from 2° to 30° C. (by a normal air-thermometer). If the directly observed changes of volume be taken as ordinates, and the temperatures as abscissæ, a curve is obtained, differing little from a straight line. A close examination of the numerical values shows that the mean specific heat of distilled water from 2° C. slowly increases to a maximum between 20° and 21°, beyond which, to 30°, it slowly decreases; but the divergences from the mean value are always very slight. According to the mercury-thermometer, the maximum of the specific heat is about 12° C., instead of 20°. Prof. Neesen does not regard the numerical values as absolute, but merely, for the present, indicative (*orientirende*); and he hopes to verify them by further measurements.—Dr. Hertz reported on experiments which he had made on the vapour-tension of mercury, by a different method from that lately described by Dr. Hagen. The vapour-tension was measured at high temperatures, and values were obtained which likewise were smaller than Regnault's, but greater than those found by Dr. Hagen. From his values, Dr. Hertz calculated a formula, according to which he produced a curve of the vapour-tension of mercury with varying temperature; its zero point being at absolute zero (– 273° C.). For low temperatures 0° C., 10°, and 20°

the values he deduces from his formula, are under those obtained experimentally by Dr. Hagen for the same temperatures.

Berlin

Physiological Society, June 2.—President, Prof. du Bois-Reymond.—Prof. Kronecker reported upon the experiments which Dr. Melzer made to determine the action of the vagus and superior laryngeal nerves upon respiration. The idea that the action of the vagus in respiration has already been definitely determined, proved to be unwarranted by the facts of the case. It is known that stimulation of the nerve can both suspend inspiration and expiration; but the conditions of the opposed effects are still to be investigated. Now the experiments of Dr. Melzer have shown that these conditions are very manifold and complicated. In a succession of cases, it is the strength of the electric current that determines a particular effect; slight stimulation of the vagus, producing a cessation of respiration in inspiration, great stimulation producing the cessation in the position of expiration, whereas stimulation of medium intensities produced cessation in an intermediate position. Further, the condition in which the respiratory apparatus was at the moment of stimulation of the vagus, determined the results of the stimulation; the effect of an equal degree of stimulation during inspiration being exactly the reverse of what it would have been if applied during expiration. Simultaneous stimulation of the vagus and the superior laryngeal had likewise very diverse effects. If one nerve was more strongly stimulated than the other, the effects of the more strongly stimulated nerve overcame those of the other. If the stimulation in both was equally strong, the results were cessation, either in the position of deep expiration (this taking place when the vagus assisted the action of the superior laryngeal), or in an intermediate position when the two nerves acted antagonistically. Dr. Melzer has also had opportunities of observing individual differences in the action of the vagus, and supposes that the sex of the animal experimented upon may have some influence. Since Hunter's time there have been very few attempts to count the pillars in the electric organs of the Torpedoes, and his view as to their number was universally received as accurate. By the numerous careful countings of Prof. Fritsch, on the contrary, it was discovered that the number of the pillars only differed slightly in large and small specimens of the same species, being often even greater in small specimens than in large ones; embryos of Torpedoes were examined by him, and these already exhibited the same number of pillars as are to be met with in adult specimens of the same species. On the whole the number of pillars in several species of Torpedoes, which are to be regarded as "good species," is pretty nearly the same. It varies between 400 and 600; very large differences in the number of the pillars are to be regarded as "species-characters," and are to be taken into consideration in diagnosis. And from this point of view Hunter's results admitted of an explanation. For Herr Fritsch had an opportunity of seeing two preserved specimens of the American *Torpedo occidentalis* in Vienna. These were, in spite of their shrinking in the spirit, one metre long, and they turned out, when a calculation was made of the number in their electrical organ, to have more than 1000 pillars; it is hence probable that Hunter's giant electric rays were specimens of *Torpedo occidentalis* that were washed upon the English coasts by the Gulf-stream, and that Hunter's enumerations do not in the least contradict the doctrine of preformation.

Paris

Academy of Sciences, June 19.—M. Jamin in the chair.—The following papers were read:—On the reaction-current of the electric arc, by MM. Jamin and Maneuvrier. With a Gramme machine and an arc between unequal carbons, or between some metal and carbon, there is a differential current, by which a galvanometer is affected—largely when copper, zinc, or mercury is used; little (and about equally) with lead, iron, and carbon: these latter show the greatest resistance. The current is explained, not by a difference of resistance, but by an inequality in the inverse reactions of the arc in the two directions. With a mercury arc, the differential current wholly changes the working of the machine, one system of currents being greatly weakened, while the other grows in strength.—On the reciprocal displacements of halogen substances, and on the secondary compounds which rule them, by M. Berthelot.—Separation of gallium, by M. Lecoq de Boisbaudran. He describes the separation from zirconium, manganese, and zinc.—M. du Moncel presented his work, "On the Microphone, Radiophone, and Phonograph."—Total eclipse of the sun observed at Souhag (Upper Egypt), May 17 (civil time), 1882, by M. Thollon.—Same subject: Observations of M. Trépied. He concludes as follows: The position of the green line of the corona corresponds exactly with that of 1474 (Kirchhoff). The relative intensities of dark lines do not seem to be preserved in the spectrum of bright lines. There seems to be a relation between the frequency of the spots and the structure of the corona. There was undoubtedly an increase of intensity of absorption lines in the group B, on the moon's contour; but the author cannot confidently infer a lunar atmosphere.—Same subject, by M. Pinseux.—The President, on a proposal by M. Dumas, asked the Astronomical and Navigation Sections to prepare a programme of observation for the solar eclipse in 1883.—A letter from M. Ferry announced the opening of the Volta competition for a second period of five years.—On a linear equation, by M. Darboux. The displacements through small dilatation or condensations produced in any indefinite homogeneous and isotropic medium, are calculable like a Newtonian attraction, by M. Boussinesq.—On the determination of carbonic acid in the air at Cape Horn, by MM. Müntz and Aubin. They describe apparatus for their method, furnished to Dr. Hyades, who has been familiarised with its use.—On the products of distillation of colophany, by M. Renard.—On microzymas as cause of the decomposition of oxygenated water, by the tissues of animals and plants, by M. Béchemp. He shows that the microzymas of different organs and tissues show unequal energy in action on oxygenated water. Numerical results are given in a table. The microzymas of the lung have the greatest activity; it is as great at first as that of bioxide of manganese, but soon diminishes. Microzymas of the blood and the liver rank next.—On various properties of hydrocyanic acid, by M. Brame. The bodies of animals poisoned with the acid remained in good preservation after a year, though sometimes exposed to 38° C. Preserved in closed vessels, they lose the smell of the acid, and acquire that of formiate of ammonia, which is found in the serous liquid. To embalm with the acid, a little of some substance which absorbs water while hardening (chloride of zinc) should be introduced after the acid.—Chemical composition of different layers of a lava current of Etna, by M. Ricciardi. There is more sesquioxide of iron in the parts in contact with aqueous vapour and atmospheric air.—Lithological determination of the meteorite of Estherville, Emmet County, Iowa (May 10, 1879), by M. Meunier.—On the branchia and circulatory apparatus of *Ciona intestinalis*, by M. Roule.—Comparison of alkaline chlorides as regards toxical power or minimum fatal dose, by M. Richet. These experiments, with chlorides of lithium, sodium, potassium, rubidium, and cæsium, were on guinea-pigs, and by injection under the skin. There seems to be no relation between atomic weight and toxical power.—M. Neujean, in a note, proposed manufacture of manures from the basic scoriæ (containing 10 to 15 per cent. of phosphoric acid) from Bessemer retorts, Martin furnaces, and others.

CONTENTS

THURSDAY, JULY 6, 1882

CLIFFORD'S MATHEMATICAL PAPERS

Mathematical Papers. By William Kingdon Clifford. Edited by Robert Tucker, with an Introduction by H. J. Stephen Smith. (London: Macmillan and Co., 1882.)

Mathematical Fragments; being Facsimiles of his Unfinished Papers Relating to the Theory of Graphs. By the late W. K. Clifford. (London: Macmillan and Co., 1881.)

ONLY those who wander much through the aridities of modern English mathematical text-books, whose duty compels them daily to read such literature, and who know

> "The mispent tyme, the service vaine,
> Whilk to considder is ane pane,"

can understand the pleasure of reviewing a book like Clifford's Papers. Here there is no occasion to yawn over page after page of commonplace, to mark with wonder the hundredth iteration of an ill-founded inference, to trace with languid amusement the method and arrangement of our ancestors, nay, the hereditary dots and dashes decrepid in the fourth generation. On the contrary, the novelty and variety alike of subject and of treatment is almost confusing, every page shadows forth some new idea, every line is informed with the personality and with the genius of its author.

Clifford was one of the bright spirits, all too few in number, who, in a generation, whose educational system is devoted to the encouragement of mediocrity and the cultivation of sciolism, saved the English school from the reproach of inability to follow their leaders. He was one of the select few who sat at the feet of Cayley and Sylvester, and shared their genius. When we compare him with the former of his great masters, he appears at first to want the steadfast purpose and rugged strength of our mathematical giant. The extreme, almost boyish vivacity of his style, and the refined elegance and studied variety of his methods give an impression of this kind which a nearer acquaintance with his work speedily dispels. Apart from his great originality, this elegance, popularity in the best sense, of style gave Clifford a specially important place among the leaders of the English School of Mathematicians, a place which there seems to be none left to fill. It was by his assistance that many were led to scale the almost inaccessible heights on which stand the structures of modern mathematics.

In some respects the exuberant philosophy of his popular works, especially his lectures, in which the more striking conclusions of modern mathematical science were presented to the uninitiated, must have harmed his reputation for solidity of thought. We are also inclined to doubt whether some of the enthusiastic non-mathematical souls that thought they had assimilated his teaching, really after all rose to the conception of Riemann's finite space of uniform positive curvature, in which the problem is solved of

> "Einer dem's zu Herzen ging
> Dass ihm sein Zopf so hinten hing,
> Der wollt' es anders haben."

Such a flight is given only to the sons of Genius, and to those who have in the first place painfully exercised their pinions in less ambitious journeys. Still these lectures of Clifford did good service in drawing the attention of the rising generation to the revolution that is taking place in the very elements of exact science. If every physical discovery of permanent or passing importance is to have its day in the drawing-room and the lecture-hall, why should the trumpet of mathematical progress not be blown occasionally in the streets of Gath and Ascalon? If too many be *called* in this way, some few may still be *chosen*. To these few the volume of Mathematical Papers will furnish the best help available in the English language to enable them to follow their calling. To our mind the popular lectures are cut too much after the passing fashion of the present day; and we should be surprised if the majority of those best qualified to judge of Clifford's work did not agree with us that it will be on the present volume that his future fame will rest. In our poor judgment there is ample foundation.

It would scarcely be proper here to criticise the papers in detail, with the view of pointing out the exact amount of originality in each. Besides, even if the reviewer felt more confident of his judgment in such a matter, the task were a needless one, for it has been done already, in the admirable introduction, by an authority to whom every English mathematician will at once bow.

The Papers have a somewhat fragmentary aspect. This is due in part to the immense range of Clifford's mathematical sympathy, which led him to write on a great variety of subjects; but mainly to the fact that many of the papers are actually unfinished, some of the most important being indeed mere sketches. Clifford seems to have cared, comparatively speaking, but little for the mere mathematical *Art;* his interest was reserved mainly for methods and principles. Accordingly we find him much occupied with new and far-reaching theories; and many of the memoirs in this volume are merely the outlines of vast schemes of work, which life and leisure were denied him to accomplish.

Besides advances in the Theory of Algebraic Integrals, the development of Projective Geometry, and the enormous extension of analysis that is included under the title of Higher Algebra, two great generalisations have marked the progress of modern mathematical science. The first of these is the extension of the axioms of geometry, which originated with Gauss, Bolyai, and Lobatschewsky, and was perfected by Riemann, and the theory of an n-fold manifoldness (Mannigfaltigkeitslehre) of which tridimensional geometry in this extended sense is only a particular case, Euclidian geometry a more particular case still. The second consists in a somewhat similar extension of the Axioms, or more strictly speaking, of the Laws of Operation, of Algebra, begun independently by Hamilton and Grassmann, and resulting in the first instance in the Quaternions of the one and the Ausdehnungslehre of the other. Both these generalisations have been progressive, and both appear to be pregnant with mighty results for the future. Clifford seized upon them with the instinct of genius. They pervade and colour the whole of his work, and the student who wishes clearly to understand the tendency of much that he has done must begin by attaining some mastery over these fundamental novelties. Great assistance will be obtained

VOL. XXVI.—NO. 662

from the elementary exposition of them given by Prof. Smith in his introduction to the Papers, pp. xl. *et seqq.* We should like, however, if we might venture to differ from so great an authority, to take exception to his definition of *flatness* by means of the notion of *planeness*, and to the introduction of the idea and the word *curvature* into an elementary exposition of the properties of space. This seems at best an explanation of the less by the more difficult; and, after all, the use in this case of the word *curvature* is of questionable propriety (although sanctioned by the highest authority), inasmuch as it suggests not only true but also false analogies. It is very well in the hands of a mathematician, to whom it suggests merely that a certain common apparatus of mathematical formulæ is applicable to a particular class of manifoldness and to a particular kind of surface; but to the mathematically untrained or half-trained reader the word suggests the paradox that portions of space on the two sides of a plane in elliptic space both are and are not congruent. Much harm has, we are persuaded, been done by this unfortunate usage of words. A similar piece of mystery making has been practised with n-dimensional space; the language of mathematicians concerning which has been retailed to ordinary simple-minded people as if it had the literal sense they naturally attach to it.

Clifford's papers on the geometry of hyper-space began with his translation of Riemann's famous Habilitationsschrift on the hypotheses which lie at the basis of geometry. He establishes a close connection between the generalised geometry and the generalised algebra in the Preliminary Sketch of Biquaternions, to our mind one of the ablest of his papers. He farther develops the subject in the memoirs "On the Motion of a Solid in Elliptic Space," "On the Theory of Screws in a Space of Constant Positive Curvature," "On the Free Motion under no forces of a Rigid System in an n-fold Homaloid." The kinematic of elliptic space as given by Clifford, and developed quite recently by Dr. Ball, forms one of the most elegant and attractive of modern geometrical theories. The starting point may be said to be the finding of the analogue in elliptic space to Euclid's parallel. In the modern geometrical sense a parallel (*i.e.* a line intersecting another at an infinite distance) cannot of course exist in elliptic space except as an imaginary line. If, however, we define a parallel as the straight equidistant from a given straight line, then through every point in space two parallels (a right and a left parallel as Clifford calls them) can be drawn to a given straight line. This appears at once by drawing at the given point a tangent plane to the equidistant surface of the given straight line, which it will be remembered is, in elliptic space, an anticlastic surface of revolution of the second degree, every zone of which is congruent with every other of the same breadth. This tangent plane meets the surface in two rectilinear generators, which intersect at the given point and have the property of equidistance from the given line. Parallels in this sense are of course imaginary in hyperbolic space, Euclid's parallel being the transition case for parallels in both senses. It seems a pity that a new word has not been used for this species of parallel.

It follows at once by synthetic reasoning of the simplest kind (in which we may in fact dispense with the aid of biquaternions or analytical aid of any kind) that almost all the properties of Euclidian parallels and parallelograms have their counterpart in the theory of Clifford's parallels, due attention being paid to the distinction of right and left. It is shown that a motion of a rigid body is possible in elliptic space such that every point moves in a right parallel, or every point in a left parallel, to a given straight line. A motion of the first kind is called a right vector, a motion of the second kind a left vector. The composition of two right vectors gives a right vector, and two left vectors a left vector; whereas the composition of a right vector with a left vector gives the most general motion of a rigid body, which Clifford calls a motor. It was to represent the ratio of two such displacements that Clifford invented his Biquaternion. Translation, strictly analogous to that in Euclidian space, *i.e.* rotation about the line at infinity does not exist in elliptic space. We may, of course, cause a body so to move that every point of it remains equidistant from a given line, and *in the same initial plane with that line.* Such a displacement is the same as a rotation about the polar of the given line, and is hence called by Clifford a Rotor. We have then the fundamental proposition, that every motor can be represented in an infinite number of ways as the sum of two rotors, but uniquely as the sum of two rotors whose axes are polar conjugates. It is the abolition of the line at infinity, whereby duality is made perfect, that gives the peculiar completeness and elegance to the properties of elliptic space, and fit it to be the paradise of geometers, where no proposition needs to wander disconsolate, bereft of its reciprocal.

To the second great branch of mathematical theory above alluded to, Clifford made exceedingly important contributions in his memoirs on the "Applications of Grassmann's Extensive Algebra," and "On the Classification of Geometric Algebras." Following, to some extent, in the footsteps of B. Peirce, whose epoch-making memoir has been given to the public at last in the *American Journal of Mathematics* for the current year, Clifford treats the subject with an incisive vigour all his own. The point of view (indicated by the word *geometric*) is no doubt limited, just as Peirce's is in another way; and there may be some doubt, as yet, as to the exact nature of the foundations upon which the reasoning rests. There is a lingering trace of the old sophistry in Peirce's work, here and there, at least so it appears to us; a reliance still upon ideas *a priori*, and a reluctance to abandon the restrictions imposed upon algebra by its arithmetical origin. Yet there can be no question as to the great value of the results already obtained and the immense extension of the mathematical horizon thereby effected. Already the attention of mathematical workers has been powerfully drawn to the matter, and there is hope that ere long another great theory equal in importance to the Mannigfaltigkeitslehre will drive its roots through the mathematical soil.

We have dwelt on two of the subjects touched upon in the "Papers," because they seem to us to be of the greatest immediate importance, and to show Clifford at his best as an original mathematician. But it must not be supposed that there is no other food for the mind mathematical in this volume. On the contrary, not one of these papers but is full of delight and edification, even for the most highly educated reader. The charming simplicity of their style, the omission of everything like superfluous detail, and the great variety and importance of the subjects treated, will make the book an indispensable *vade mecum* for the tyro in pure mathematics. We think with regret of the infinite use it would have been to us in our learning years; from it we could have gathered, easily and pleasantly, in the pliant hours of youthful leisure, what we are now constrained to glean, in the intervals of ordinary drudgery, from partial treatises, and articles in foreign periodicals often the driest of the dry.

We must not conclude this notice without alluding to the appendix to the volume of papers, the most important parts of which are the fragment of a treatise called "The Algebraic Introduction to Elliptic Functions," the Notes of Clifford's Mathematical Lectures, and the problems and solutions contributed to the *Educational Times*. The fragment on elliptic functions, which deals with the Theta functions, has great value, as it gives a treatment of the subject not to be found in any English text-book. The lecture notes will be most useful to such teachers of mathematics as are sufficiently alive to the need of some modification of our traditional methods to take advantage of them. They remind us of the irreparable loss we have sustained by Clifford's early death of a doughty champion in the reformation of our degenerate system of mathematical education, which strangles the youthful mathematician ere he is born. It is, perhaps, too much to expect that the veteran chiefs of mathematical science should enter into the work of the drill-sergeant of mathematical recruits. They cannot be asked to devote their time to the petty work of reorganising the teaching of geometry and algebra in our schools and colleges. The more reason that we should mourn the departure of one who was able to take his place with the gods immortal, and yet disdained not to mingle with us mortals in the dusty fray of the Trojan Plain.

The handsome folio of lithographed manuscripts relating to the Theory of Graphs, forms one more monument of Clifford's genius, and affords us one more reason to lament our loss. Fully as we appreciate what he has actually done for us, and much as we are grateful for it, we cordially sympathise with the feeling that prompted the editor of the papers to put on the title-page the saying of Newton concerning Cotes: "If he had lived, we might have known something;" for, if we measure Clifford's promise by his actual performance, we see that he certainly died before his work was well begun.

G. CHRYSTAL

OUR BOOK SHELF

Winters Abroad. Some Information respecting Places visited by the Author on account of his own Health. Intended for the use of Invalids. By R. H. Otter, M.A. 8vo., pp. 236. (London: John Murray, 1882.)

THE places visited by the author are Australia, including Melbourne, Sydney, Queensland, and the Riverina, Tasmania, Algiers, Egypt, Cape of Good Hope, and Davos. He gives a short account of the places in the order in which he visited them, written in an easy readable style. The author's object in writing is to give invalids an idea of the easiest routes by which to reach health resorts, the kind of accommodation they may expect, the weather they must be prepared for, and the occupations and amusements which the several places afford. He has kept this object constantly before him, and has consequently produced a book which, notwithstanding its moderate size, clear, large type, and easy style, yet contains a great quantity of solid information which is quite trustworthy as far as it goes. From the nature of the work, embodying as it does the author's personal experience only, it is not complete, and might possibly mislead invalids who decided to follow the author without reference to the exact condition of their own lungs. For example, the author prefers the route to Egypt by the P. and O. steamers, and for many persons this may be excellent, but it involves a passage through the Bay of Biscay, with the possibility of rough weather, which to many invalids might be exceedingly dangerous. He has done good service to invalids by warning them of the necessity for warm clothing everywhere, but he speaks of throwing his coat on his bed as an additional covering, and so appears not to have had with him that greatest of all comforts to an invalid, an eider down quilt, which keeps him warm in bed, sofa, or chair, and when packed in a waterproof cover, is easily carried and serves at need for a pillow or footstool. In his remarks on Davos, the author observes, that through want of knowledge of the kind of cases for which the climate is suitable, many persons are sent there who would be much better elsewhere, and makes a most sensible suggestion that the authorities of Brompton Hospital should send thither a certain number of test cases. Proper accommodation and medical attendance would have to be provided for them, but the expense would not be very great, and might be met by special subscriptions for the purpose, while "the benefit to many of the sufferers and to the world at large might be incalculable." The origin of tubercle from germs, which has recently received such confirmation from Koch's experiments, as well as the increasing probability that under certain conditions these germs may be inoculated, afford a hope that consumption may ere long be brought, like typhoid fever, into the category of preventible diseases. But even after its causation is known as well as that of typhoid, cases will continue to occur from ignorance, stupidity, or negligence; but we may trust that it will no longer be the awful scourge which it is at present. To those who suffer from it, and who require to winter abroad, the present work will be a useful adviser and companion, and we would also strongly recommend its perusal to medical men who are personally unacquainted with the health-resorts to which they recommend their patients.

A Sequel to the First Six Books of the Elements of Euclid. By John Casey, LL.D., F.R.S. (Dublin: Hodges, 1882.)

THIS handy book has deservedly soon reached a second edition. In this way it will be seen that it has met a want. "The principles of modern geometry contained in the work are, in the present state of science, indispensable in Pure and Applied Mathematics and in Mathematical Physics; and it is important that the student should become early acquainted with them." The author appears to have thoroughly revised the text, and he has added many notes of interest, a few figures, we believe, and several problems: the enunciations occupy more space; that is, such terms as parallelogram are given in full, instead of being symbolically represented; but in the demonstrations the symbols are retained. An index has been added at the end.

We have noted a few errata: in the list of errata, for 4 read 74; p. 39, l. 15, "AB" should be "A C," as in first edition; on pp. 95, 157, the names of Sir W. Thomson and M. Mannheim are incorrectly printed; p. 110, the reference to *Educational Times* should be to the "reprint" from that journal; but these are very slight slips. We recommend Dr. Casey's book with increased confidence for use in the higher forms of our schools.

Il Telefono, il Microfono, la Bussola, Istrumenti Rivelatori delle variazioni atmosferiche. Di A. V. G. Mocenigo. 131 pp. (Vicenza, 1882.)

THIS little work deals with the physics of the earth as revealed by the telephone, the microphone, and the compass. Amongst the subjects dealt with are the perturbations of the earth's magnetism, atmospheric electricity, earth-currents, particularly in relation to their study by the aid of the telephone, and seismological movements of the earth's crust as revealed by the microphone. For the study of the latter class of phenomena the author has devised an earthquake-pendulum-microphone. In this instrument one piece of carbon is hung by a long wire vertically above another attached to a rigid frame, the upper carbon resting with very light pressure against the approximately flat top of the lower. Any disturbance of the verticality of the apparatus causes a variation in the contact, and gives rise to grating sounds in a receiving telephone. The author appears to attribute earth-currents to the rotation of the magnetic mass of the earth; and he proposes to utilise them for working telephones in regular fashion. A large part of the book is taken up with correspondence between the author and Signor de Rossi.

S. P. T.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

An Observatory for Auroræ

J'AI l'honneur de vous annoncer que, dans le cours de l'automne prochain, j'ai l'intention de faire proposer au gouvernement norvégien la création d'un établissement ayant pour but l'investigation et l'observation de l'aurore boréale et des autres phénomènes du magnétisme terrestre.

En me permettant, M. l'Editeur, de vous communiquer ce projet pour vous en demander votre avis j'indiquerai en peu de mots les motifs qui m'ont porté à chercher la réalisation de cette idée, nouvelle encore sous bien des rapports.

La théorie du magnétisme terrestre est un des problèmes qui présentent à la science naturelle moderne les plus fortes demandes d'être examinés. Si la science n'a pu résoudre, jusqu'à présent, qu'une petite partie des nombreux problèmes noués à ce terrain de recherche—pourtant, à chaque progrès elle a pu prouver, de plus en plus clairement, l'énorme importance des phénomènes du magnétisme terrestre pour les relations physiques de la terre. Par la découverte de la connexion existant entre ces phénomènes et des évènements sur la surface du soleil, la question a gagné une portée cosmique.

Il sera inutile, M. l'Editeur, de vous rappeler le grand et important rôle joué dans toute la vie physique de la terre par les forces du magnétisme terrestre, par leur état changeant et par leurs périodes, soit qu'elles se présentent dans le jeu énigmatique de la lumière polaire, soit qu'elles se prononcent dans les mouvements changeants de l'aiguille aimantée, ou par leur influence sur le réseau télégraphique de pays entiers.

Aucun pays en Europe, peut-être même pas sur toute la terre, n'offre à l'investigation de ces phénomènes des conditions si favorables que la Norvége. Ayant une étendue de presque 2000 kilomètres —du 58me au 71me° N.—elle s'étend plus loin vers le Nord qu'aucun autre pays habité. Elle est plus rapprochée du foyer des perturbations magnétiques, qu'aucune autre partie du continent européen. La zone maximale de l'aurore boréale traverse la partie Nord et Nord—Ouest du pays. Un réseau continu de fils télégraphiques s'étend de son extrémité Nord à celle du Sud. Les lignes téléphoniques de Drontheim et de Bergen sont celles de toute la terre, qui sont le plus rapprochées du pôle.

A aucun autre pays ne s'adresse donc plus directement la demande de prendre l'initiative énergique de l'investigation des mystères du magnétisme terrestre.

Ayant reconnu ces nombreux avantages, si négligès jusqu'à présent, j'ai tâché, pendant ces dernières années, d'entreprendre, de ma propre initiative, et avec les ressources d'un seul individu, une partie de la grande œuvre qui nous reste encore sur ce terrain relativement si peu exploité. Dans l'automne de 1878 je fis, pour la première fois, répandre dans toutes les parties de la Norvége l'invitation à contribuer (Actes de la société des sciences de Christiania, 1880, No. 6) 839 observations de 154 aurores prises de Sept. 1878—Avril 1879 de 132 stations, principalement en Norvége.

Ce résultat me mit à même de prouver, que l'aurore boréale est un phénomène beaucoup plus fréquent, même hors des régions polaires, qu'on ne l'a supposé jusqu'à présent, et que, dans un territoire comme celui de la Norvége, il n'en manque presque jamais, même dans une année de minimum.

A compter de ce modeste début, l'entreprise s'est développée bien rapidement; non seulement la Suède et le Danemark, la Finlande, l'Angleterre, le Groenland et l'Islande sont aujourd'hui comprises dans le réseau d'observation. Le travail complémentaire à l'égard des observations de l'hiver de 1879-80, quoique fini depuis longtemps, n'a pas encore été publié; cette série est bien plus considérable et plus complète que celle du premier hiver, et contient 1600 observations de 249 aurores boréales prises de 357 stations. Le matériel de l'hiver de 1880-81 est bien plus riche encore que celue de l'hiver passé; il contient jusqu'à 5200 observations d'environ 300 aurores boréales, prises de 675 stations. Le résultat de l'hiver de 1881-82 sera probablement encore plus vaste; je suis en correspondance, dans ce moment avec 1000-1500 observateurs dans tous les pays de l'Europe septentrionale.

Comme supplément à ces observations des aurores boréales je suis parvenu à faire noter, à ca. 50 stations télégraphiques, suédoises et norvégiennes, toutes les perturbations ayant lieu dans les fils, avec indication de l'heure, de la force, de la direction etc. Il résulte de ce travail un matérial aussi vaste, aussi étonnant que celui des observations des aurores boréales, les perturbations télégraphiques se montrant aussi fréquentes que les aurores elles-mêmes, et presqu'aucun jour ne passe en Norvége, que les lignes n'éprouvent une perturbation quelconque. Dès que j'aurai reçu les observations d'une année entière, je pourrai les publier et les faire accompagner d'un atlas, montrant carto-graphiquement les perturbations télégraphiques de chaque jour, les aurores boréales et les orages observés le même jour, avec indication de l'heure et de l'endroit, ainsi que la quantité de nuages le soir sur tout le terrain d'observation.

J'ai réussi à construire un appareil qui, mis en communication avec un fil télégraphique, note graphiquement tous les courants perturbateurs selon l'heure, la force et la direction. Ce rhéographe sera bientôt mis en communication chaque nuit avec une ligne télégraphique (direction N.—S., longueur de ca. 1400 kilomètres) qui n'est pas employée pendant la nuit pour le service télégraphique; pendant la journée il sera mis en communication avec une ligne téléphonique spéciale.

A côté de cette activité, j'ai rendu compte des résultats déjà gagnés dans plusieurs traités qui sont, ou publiés ou en état de préparation. Sans compter les ouvrages déja cités, j'ai pu contribuer, d'après des observations prises en Groenland, à l'explication des périodes journalières, annuelles et celles d'onze ans de l'aurore boréale (voir "Sur les périodes de l'aurore boréale"—extrait de l'annuaire 1880 de l'institut météorologique danois). Dans un traité qui sera publié dans les actes de la société des sciences de Christiania, j'ai discuté la période dépendant du clair de la lune; dans "Archiv for Mathematik og Naturvidenskab 1881" j'ai publié une monographie assez détaillée de l'aurore boréale du 17 mars 1880. Je prépare enfin un catalogue de toutes les aurores boréales observées en Norvége depuis la période la plus reculée jusqu'a nos temps, dont le travail préparatoire est presque fini.

Je peux encore ajouter que je passerai l'hiver prochain (Septembre-Avril) à Kautokeino dans le Finmark (69° 1′ lat. N., 21° 0′ long. E. P.) pour y faire, en commun avec la station polaire norvégienne Bosekop, située à 100 kilomêtres plus loin vers le Nord, des observations surtout à l'égard de la parallaxe de l'aurore boréale.

Quoique j'aie trouvé tout appui et encouragement possible chez les gouvernements et les institutions scientifiques des royaumes du Nord, il est évident, qu'une organisation si étendue et si compliquée doit finir par épuiser les forces d'un seul homme, surtout comme je suis obligé de vouer la plus grande partie de mon temps à une activité différente. Il est également clair, qu'une entreprise, n'ayant pour appui que l'initiative individuelle, ne peut être poursuivie avec autant d'exactitude et de perfection, qu'étant basée sur une institution publique. Il me semble, enfin, que ces recherches sont d'une telle importance, qu'il est à désirer, qu'elles soient continuées si énergiquement et sur une échelle si complète que possible. Cela ne peut se faire, selon mon avis, que par la création, par l'état, d'un établissement spécial pour ces recherches. Les principes sur lesquels je voudrais voir basé un tel institut, les voici :

(*a*) L'institut sera établi à Drontheim (63° 27′ lat. N., 8° 5′ long. E.P.), endroit à peu près central dans le pays et mis en vive communication avec l'étranger par des bateaux-à-vapeur et des chemin-de-fer. Situé à 30° S. seulement du cercle polaire, il est assez rapproché de la zone le plus active des forces du magnétisme terrestre, ce qui, entre autres choses, est aussi prouvé par le fait que, pendant l'hiver de 1880–81, non moins de 62 aurores boréales ont été observées par un de mes observateurs, et que les perturbations télégraphiques y sont aussi très-fréquentes; dans la période 1 Julliet 1881–30, Avril 1881 on en a compté a pas moins de 122 jours (plus de 40$_{0}$/^{0}) dont une partie insignifiante provenant des orages.

(*b*) Il sera construit pour l'institut, sur un emplacement à l'horizon libre, un édifice spécial, situé de manière à ne pas être gêné par la lumière artificielle. Sans compter l'appartement du directeur, l'édifice doit contenir une salle de travail, des cabinets pour les instruments, une tour, contenant une chambre à vue libre dans tous les sens et une plateforme.

(*c*) L'institut tâchera de devenir le point central des observations des aurores boréales en Europe. Tout en faisant lui-même toutes les observations possibles, il veillera sur la régularité des observations dans toute l'Europe septentrionale, dans l'Islande et dans le Groenland, il en chargera les navires navigant les mers arctiques etc.

(*d*) L'institut se fera également le centre des observations des perturbations télégraphiques, recues de toutes les lignes télégraphiques de Norvége et de Suède. Le rhéographe cité plus-haut sera employé à des observations nocturnes sur une ligne longue. De semblables recherches seront faites à l'aide des lignes téléphoniques de Drontheim.

(*e*) Sans compter les spectroscopes, les théodolites pour les aurores etc., l'institut sera pourvu d'une série d'instruments de variation, à l'action spontanée, placés dans un pavillon particulier.

(*f*) L'institut publie tous les ans les observations recueillies et classifiées par lui, ainsi que leurs résultats.

Je suis persuadé qu'un observatoire, basé sur ces principes, pourra rendre d'importants services à la science, et j'espère que la réalisation de cette idée sera accueillie avec joie par le monde scientifique.

J'adresse cette communication à vous, M. l'Editeur, et à d'autres autorités reconnues sur ce terrain de la science, pour que cette question soit soumise à votre jugement. Je vous prie de vouloir bien me communiquer votre opinion sur les mérites d'un tel institut, afin que le poids de votre nom me serve d'appui dans mes efforts pour la réalisation de mon projet—si toutefois l'idée gagne votre approbation, ce dont je ne doute pas. Si vous y ajoutiez encore la bonté de formuler des propositions eventuelles et des conseils pour l'organisation de l'institut, pour son plan de travail etc., je vous serais également très reconnaissant.

Dans l'espoir d'être honoré d'une prompte réponse, qui pourra être conçue dans quelque langue que vous deviez désirer, j'ai l'honneur, M. l'Editeur de vous prier d'agréer l'expression de mes sentiments les plus distingués.

Bergen en Norvége, Juin SOPHUS TROMHOLT

Hydrophobia and Snake-bite

IT has been the fashion of late, in newspaper and other commentaries on the numerous experiments in search of an antidote for serpent-venom, which are now attracting general notice in different parts of the world, to compare snake-bites with hydrophobia, and to raise hypotheses and suggestions that the remedy, when it is discovered, for the one, will be found also to effect the cure of the other. Such a surmise, one would imagine, must be based on a very superficial knowledge, even of the rough outlines of the two affections, and in total ignorance of their pathological characteristics. What are their points of similarity and distinction, dismissing all rhodomontade involving such terms as "ferments" and "active principles," "germs," and "vibriones"—expressions which are very convenient to make use of as signifying an *unknown something*, but which, in their literal meaning, indicate definite actualities, the existence of which has certainly never been shown by tangible demonstration in the present instances? Hydrophobia and blood-poisoning by a venomous snake-bite are alike, then, in being produced by an animal poison, commonly conveyed by the living animal; in being of intense virulence, accompanied by many parallel symptoms denoting violent constitutional disturbance, and great prostration of the vital powers; and, *in some cases*, in leaving certain post-mortem lesions which are identical. But there all likeness ceases; and even without considering the grand differences which exist between them, however viewed, I think we shall find these items of resemblance when analysed a very insufficient foundation for the theory of the probability of a common antidote. To begin with, the poison in one is a natural secretion, provided for the distinct physiological purpose of enabling the reptile to secure its prey; in the other, a new and morbid product generated by disease in a secretion naturally innoxious—whether by chemical decomposition or by the formation of new compounds from materials pre-existent there or from others specially eliminated from the blood, we cannot say. For it is to be observed that neither the microscope nor chemical examination has afforded us any clue to the mysterious ingredient which constitutes the toxæmic property of these fluids as yet. Then, in the second place, as to the acuteness of the symptoms of vital disturbance; neither the symptoms themselves nor their severity are specific to these affections, but are such as might be produced by any grave interference with the relation of tissues or function—a deadly mineral or vegetable poison, the rapid course of a zymotic disorder, violent concussion, or the rupture of an internal organ. Lastly, the occasional identity of the appearances after death from snake-bite with those which are constant in hydrophobia (notably those observed in the spinal cord) are little to be relied upon, partly on account of their comparative infrequency, and partly because they are not in themselves primary evidences of the introduction of the poison, but *tertiary* to it—secondary to the effects which result from the altered blood and its new and vital function on other tissues. One is compelled to attribute such phenomena to something more than passive contamination (as the idea giving rise to some recent experiments would seem to be), and to recognise a defined potential agency in the new formation.

The fact that the hydrophobic poison is located, and undergoes a period of incubation at the seat of the original wound, even long after cicatrisation, and is not diffused in what we vaguely call the "system," draws a broad line of separation between the pathology of this disease and snake-poisoning, and renders it perfectly unique in the category of ills known to medical science. The constitutional symptoms never appear in less than three weeks after the bite, rarely under six, and may be delayed for twelve months. Could there be a greater contrast to the *impetuosity* of the changes sequent on inoculation with the poison of a serpent? Both the latter fluid and the saliva of a mad dog are incapable of producing their characteristic effects when absorbed through mucous membrane, but that is a circumstance common to most animal viruses.

There is a far greater similarity between the course of some of the rapidly fatal tropical fevers and a snake-bite, than there is between that injury and hydrophobia. The inception of a morbific agent—though of what nature, or through what channel, is uncertain; the almost *instant* development of acute symptoms—for, if there is any period of latency, it must be a very brief one; the intense disorganisation of the economy produced within a few hours; the nearly inevitable termination in death—all suggest a comparison which will not be thought strained or far-fetched by those who have witnessed the progress of these appalling diseases. My friend Dr. Fairbairn, of Rio de Janeiro, who has probably seen more of yellow fever than any man alive, and who has certainly met with greater success in his treatment of it than any other physician whose experience has been placed on record, called my attention to this resemblance, with which he had long been impressed, living in a region which afforded plenty of opportunities for observing both; so much so, that be expressed a conviction that many points of identity of process and morbid anatomy would eventually be revealed. His last words to me at parting were: "Now, mind—if you ever discover the antidote for snake-bites, you'll have a cure for yellow jack!" ARTHUR STRADLING

29, Woodford Road, Watford, Herts

The Rainfall of the Globe

IN reference to a paragraph in an article on the rainfall of the globe in NATURE, vol. xxvi. p. 206, Prof. Loomis states that the heaviest rainfall is met with in the rain-belt, which surrounds nearly the whole globe lying between the north-east and south-east trade-winds.

Having been engaged in collecting records of rainfall at sea for some time back, I may take the opportunity of saying that I have received data enough to enable me to give an estimation of rates per annum for this rain-belt.

That for the Atlantic Ocean is calculated at 133·37 inches per annum, that for the Indian Ocean at 80·55 inches per annum, that for the Austro-Chinese Seas at 107·96 inches; but none has yet been made out for the Pacific Ocean, owing to absence of observation altogether from that quarter.

In physical atlases the rain-belt is continued across this ocean in the same latitudes as it is found to exist in the Atlantic and Indian Oceans, but as yet it is only conjectural, and it may probably be found to cross in other spaces by direct observations taken at sea. The observance of rainfall on islands in the open oceans would appear to afford but imperfect means of judging of the rainfall at sea surrounding them. It is frequently found that they differ very materially, as at St. Helena, the island may be covered with mists, invisible, while the ship outside is sailing under a clear sky and fresh breeze.

The ocean rainfall, therefore, can only be made out by observations on board ships, and these are not easy to get, and also take up a long time in effecting. W. J. BLACK

Caledonian United Service Club, Edinburgh

The Recent Unseasonable Weather

MR. ARCHIBALD's letter on this subject displays great ability, and is deserving of much attention by meteorologists. Nothing can be, I think, more interesting and important than a proper interpretation of the meaning of the facts of the weather of the late extraordinary and contrasted seasons. Will you, therefore, allow me shortly to make a few remarks regarding the comparison pointed out by Mr. Arcbibald as existing between the weather of India and that of North Europe.

In the "Report on the Meteorology of India," 1877, the reporter, referring to the Himalayan regions, says: "There are two periods of cold, (1) when the snow is accumulating; and (2) when it is dissolving; and the first occurs in January and February, the latter in April and May." Again, he says: "The conclusion appears to be very strong that during the early months of the year, one very important factor in determining the peculiar features of the season is, the amount of snowfall and of snow accumulation in the Himalayan regions during the winter."

For six years past I have observed the same thing hold *generally* in the north of Europe, a cold winter being followed by a late spring and an ungenial summer, and *vice versa.* This I would therefore be inclined to regard as a general law. The weather of June, however, serves to indicate the difference between the meteorological conditions of India and North Europe. It has been ungenial, I think, solely, on account of the exceptional force and warmth of the winds of winter causing a vast detachment of the ice in the polar regions. This ice has floated into lower latitudes—has come much nearer to us—and has produced, in melting, icy winds. These commingling with the warmer tropical winds, have produced in their turn the recent changeable weather.

Our cold spring winds usually come from the east of north, but the prolongation of cold winds which we experienced in the middle of June, came from the west of north, indicating their origin to be in the masses of ice floating for the most part probably between Iceland and the American coast. Thus the movable ice has caused a high atmospheric pressure and a low temperature. The fixed ice, however, which forms by far the largest area within the Arctic Circle, has been during this winter relatively diminished, and from it, therefore, we should expect less incursion of cold winds; therefore a finer summer.

While, then, the chief influence of warm westerly winds in winter is, as I believe, to produce a fine summer, their minor influence must be, particularly when strongly developed, as they have been during the past winter, by detaching an unusual quantity of Arctic ice, to produce unseasonable weather in early summer.

The same exception would take place in India, if we could suppose some part of the winter's accumulation on the Himalayas to be carried at the close of a severe winter down into the northern plains so as to distribute in melting, volumes of cold air throughout the otherwise warm atmosphere.

Dundee, July 3 DAVID CUNNINGHAM

Is the Axis of a Cyclone Vertical?

I AM not aware if it has ever been suggested, in explanation of the frequent (or rather, usual) incompleteness of cyclonic disturbances, that the axis of the cyclone may be inclined, and consequently only one side of the disturbance affect the earth's surface, the other half being at a greater or less elevation, according to the amount of the inclination, and thus (so far as wind currents are concerned at least) lost to us.

My own observations of storms in this country point to a southerly inclination of the cyclonic axis. I should be glad to know if observers in the southern hemisphere have traced any indications of a *northern* inclination in the cyclones there.

J. A. WESTWOOD OLIVER

Belle Vue, Springburn, Glasgow, June 25

THE idea propounded by Mr. Oliver, that the axes of cyclones are inclined, is no new one, nor is it the first time that a *southerly* inclination has been inferred to exist, to account for the preponderance of winds belonging to the southerly quadrants, and the comparative absence of those belonging to the northerly quadrants of cyclones in our latitudes.

The value of Mr. Oliver's opinion on this point must depend to a great extent on the nature of the observations on which he relies.

This supposed southerly inclination was formerly attributed by Andrau and other Dutch writers (according to Réclus), to the fact that a cyclone, starting from some point near the equator, must have its rotation-axis initially inclined to the terrestrial axis nearly at right angles, and that as it moves from thence polewards, the direction of its rotation-axis remaining fixed in space, it must *apparently* become gradually more and more inclined to the local horizon in a southerly direction. This explanation is ingenious, but there are many considerations, both theoretical and practical, which militate powerfully against it.

Another view—that of the Rev. W. Clement Ley, derived from observation (principally of the upper clouds)—makes the axis of a cyclone incline backwards as regards its direction of translation, and in favour of this notion, the retardation in the occurrence of the barometric maxima and minima on the summits of Mount Washington, Pike's Peak, and Mount Michell, noticed by Prof. Loomis, has been cited.

Ferrel, however, remarks that "a retardation of just about the same amount is observable in the occurrence of the times of maxima and minima in the diurnal changes of the barometric pressure at the summits of these same mountains, which cannot be explained by means of cyclones with reclining axes," so that in all probability the same cause acts in both cases, and is independent of any such special quality of cyclones as that inferred by Mr. Ley.

The hypothesis of Mr. Ley is, moreover, so much at variance with mechanical principles and with what we should naturally infer would take place, that, as Mr. Ferrel says, "we must hesitate to adopt it, without seeking further for some more plausible hypothesis to explain the observations."

The theory of cyclones, as developed by Ferrel and others, makes it far more probable that if there is any inclination at all, it will be *small*, and *forwards*, not backwards.

Ferrel thinks it possible that the elliptical form of the isobars and rain-areas is partly due to this forward inclination of the axis.

Moreover, the preponderance of southerly and westerly winds in our cyclones cannot correctly be adduced as an argument in favour of the southerly inclination of their axes, since it is mainly due to the fact that our cyclones are for the most part secondaries, moving within the periphery of a large, nearly permanent cyclone, whose centre generally lies not far from Iceland, and thus those winds and gradients predominate, which would tend to occur in that part of the large cyclone where we happen to be situated. E. DOUGLAS ARCHIBALD

OUR ASTRONOMICAL COLUMN

The Transit of Venus in New South Wales, &c.—In his address as president of the Royal Society of New South Wales, read May 3, Mr. H. C. Russell, the director of the Observatory at Sydney, gave some account of his arrangements for the observation of the approaching transit of Venus in that colony. Provision was liberally made last year by the legislature, and a sum of 500*l*. has been placed at Mr. Russell's disposal for this purpose. With this he states he will be able to provide four high-class 6-inch equatorials, exactly similar to those which are to be used by European observers, and two of 4½ inches. There are remaining from the last transit one equatorial of 11½ inches, one of 7¼, one of 5 inches, one of 4¾, and one of 4¼ inches. He hopes to be able to take up four stations, in addition to the Observatory, with two observers and two telescopes at each point. In order to make the best of the chances of favourable atmospheric conditions, elevated points on the east coast of New South Wales, have been selected, which, it may be fairly anticipated, will have a clearer view an hour after sunrise than could be looked for near the sea-level. Mr. Russell remarks that in observing the transit of Mercury last November, the observers were stationed at Bathurst, Katoomba, and Sydney, places which he had thought were far enough apart to secure different weather; but the result showed that the weather was practically the same at the three stations. This induced the unpleasant reflection that it may prove cloudy all along the coast on December 6, and he had therefore gladly taken advantage of the recent commission to Lord Howe Island to make some inquiry as to its suitability as a station. It is found that an elevated spot is easy of access, and the weather at the hour and season is almost sure to be fine.

We have also received from the Imperial Observatory of Rio de Janeiro a report on the proposed arrangements to be made by the Brazilian Government for securing observations of the Transit. In addition to Rio, it is intended to establish a station at Pernambuco and to equip an expedition to Santiago de Cuba. The details are in charge of M. Cruls, acting director of the Observatory at Rio.

Solar Parallax from Observations of Minor Planets.—Mr. David Gill, H.M. Astronomer at the Royal Observatory, Cape of Good Hope, has arranged with a number of observatories in both hemispheres for corresponding observations of the minor planets, *Victoria* and *Sappho*, about the times of their oppositions in the present year. Victoria, in opposition on August 24, will be distant from the earth 0·89 of the earth's mean distance from the sun; and Sappho, which comes into opposition in R.A. on September 24, will be within 0·85, so that we have in each case a favourable opportunity of applying the method of determining the sun's parallax, which was advocated and also applied by Prof. Galle, the director of the Observatory at Breslau. In a communication to the *Astronomische Nachrichten*, Mr. Gill states that the necessary extra-meridian observations will be made in the southern hemisphere at the Cape, Natal, Melbourne, and Rio de Janeiro, and in the northern hemisphere at Dunsink (Dublin), Strasburg, Berlin, Bothkamp, Leipsic, Upsala, Moscow, Clinton, U.S., and probably at Kiel. From the clearer skies of the southern hemisphere, he believes that a fully corresponding number of observations will be secured there, notwithstanding the smaller number of observatories, and he invites co-operation from other establishments in the northern hemisphere, on this ground. A list of the proposed stars of comparison is given in his letter.

Comet 1882*a* (Wells).—The Emperor of Brazil, telegraphing to the Paris Academy of Sciences (of which body his Majesty is a member), reports the visibility of this comet at Rio de Janeiro, on June 17, and that three days later the nucleus was very bright, and the tail 45° long. If there be no error in the telegram, the development of the tail must have been rapid after the perihelion passage.

Prof. Zona has made a communication to the Società di Scienze Naturali of Palermo, in which he describes the undulations in the tail observed there in the week following April 14. On the 17th, in a fine sky, it is remarked of the phenomenon—"Sembra che la luce della coda vada a poco a poco diminuendo stringendosi attorno il nucleo come se venisse da questo attratta, poi ad un tratto si spande di nuovo."

EDUCATION IN THE UNITED STATES[1]

THE great work of the American Bureau of Education continues, like that of a large Reference Library among men who know its value. About 100 inquiries a day are addressed to it, and 150 letters of information are sent out on subjects varying from the Semitic language to dress-making, and including everything that comes within the limits of education. Its latest report, in which everything is tabulated, down to the opening of a normal summer school only kept open for four weeks, and in which attention is called to many matters of special interest, cannot be gone through without advantage to educationists in any civilised country, and most of all to those in our own.

If we are accustomed to think that Americans look upon their country with complete satisfaction, and as standing ahead of the Old World, more particularly in the matter of education, we shall not find such self-praise in the Government reports. A very interesting *résumé* is given of what foreign countries are doing. Attention is called to the more thorough manner in which young persons aiming at commercial pursuits are instructed on the Continent, while England is quoted as an example to be followed of the higher education of women. It is satisfactory to find, in this Report also, that the province of Ontario, in Canada, stands at the head of educating countries. There a system of free schools and compulsory attendance was established in 1871; and while the number of children within the school ages of five and sixteen was 492,460, there were actually attending schools 489,015! On the other hand, it is surprising to find the illiteracy of a very large proportion of the population of Prussia, where of 40,000,000 persons (including infants, &c.), 25,000,000 were unable to read or write!

The schools requisite to supply education to so widely spread a population as that of America are far more numerous than in our crowded country. Naturally, therefore, it is a great difficulty to find sufficient teachers properly educated and qualified for this important work. It might seem, at first, that, in a country where, on an average, each individual is better educated than in England, there would be no lack of able teachers; but teaching is an art requiring a technical education as much as any other art; and the work of those who have not had this technical training is as clumsy as most amateur work is, and is found to have the fault of superficiality. The Bureau of Education is simply an office of information and reference; it has no central control over the various States; and one result of this is, that no uniform standard of capacity is required of those who present themselves as teachers, and two standards are to be found, not only in the same State, but in the same city. A more unsatisfactory difficulty still is the favouritism and even corruption, not unfrequent in appointing and dismissing teachers, who, in many cases, seem to go in and out of office like the nominees of a government. The picture of corruption on page xxii. must surely be an extreme case; but its possibility must add greatly to the difficulty of the situation. Pennsylvania's is called a proud record, there dishonesty among school-board officials is *almost* unknown; "a few thousand dollars would cover all the losses." These things tell greatly against the business of a teacher being an attractive one, and, to add to them, in many States, as in Virginia, diminished public funds have been allotted to the common schools; the number of schools has been reduced, and the salaries of the remaining teachers lowered. In some countries in that State the local boards determined to open no schools, and to use the income for paying off debts.

The small pay of teachers, in the lowest standards especially leads them to throw up that branch on the first

---

[1] United States Report of the Commissioner of Education for the year 1879. (Washington Government Printing Office, 1881.)

opportunity—a very mischievous thing in its results—for in nothing is it more true than in the case of education that what is well begun is half done. Hence a good infant school is an immense help to all subsequent stages, and *vice versâ*. So much is this deterioration felt in Michigan, where salaries of schoolmistresses have been reduced to the level of those of domestic servants, that the attendance at the primary schools has absolutely fallen off; and the explanation of it seems to be that these faults are well known to the intelligent public of the United States, and accordingly the children are being removed to private schools. The Commissioner very aptly quotes Roger Ascham's words:

"It is a pity that commonly more care is had, yea, and that among very wise men, to find out rather a cunning man for their horse, than a cunning man for their children. . . . To one they will gladly give a stipend of 200 crowns by the year, and loath to offer to the other 200 shillings. God that sitteth in heaven laugheth their choice to scorn, and rewardeth their liberality as it should. For he suffereth them to have tame and well-ordered horses, but wild and unfortunate children; and therefore, in the end, they find more pleasure in their horse than comfort in their children."

This is not a bright picture of the work of education in America. It certainly seems an indication that our brethren there are losing faith in the old rule, that what is worth doing at all is worth doing well, but it does not go very deep below the surface of so vast a work. On the whole there continues a steady rise in numbers of both schools and pupils, though not so large since 1875, as we should have expected in such a progressive country. This rise also is almost wholly in cities, again pointing to the difficulty of supplying the *number* of schools required in so wide-spread a country. In one of the most flourishing of these cities also, Chicago, it sounds more like the Old World to read that more than 2000 children are taught in underground rooms, where the light is so bad as to expose their eyes to serious injury! In New York and New Jersey, where population in its extremes of rich and poor keeps crowding together as in older countries, the school attendance is actually falling off. In Maine, New Hampshire, and Rhode Island the population is, curiously enough, at the present time decreasing, but school attendance is increasing; not quite one-third of the population attend daily; nearly two-thirds are on the books. In nearly all Southern States there is considerably increased attendance. The administration of the Peabody Fund has had a remarkable influence in developing the school spirit in the south, in awakening the people to a sense of their obligation with reference to the support of public schools and in maintaining a high standard for such schools. This last result has been accomplished by the wise policy pursued by Dr. Sears in insisting upon a certain degree of excellence in a school as the condition of receiving aid from the fund.

An increase of more than 50 per cent. in the number of students in the Schools of Science in 1878 led to the number of these schools being raised from 809 to 884; but this increase of pupils hardly kept up in 1879. Still science, though a long way behind theology in number of schools, is rapidly gaining ground upon it, and has already far outstripped it in number of students. In 1870 there were 80 schools of theology with 3254 pupils, which numbers have grown respectively to 133 and 4738; but the corresponding numbers for science are 17, increasing to 81, and 1413, increasing to 10,914! This has called for a large increase of teachers; and, accordingly, while in secondary schools the proportion of those receiving a scientific, to those receiving a classical, education is as 2 to 5, in the preparatory department of colleges the proportion is as 4 to 5. At some of these colleges there are workshops, where the use of tools is taught to students by their being used in the production of other tools and things useful to the establishment. The Massachusetts Institute of Technology has one of these workshops upon a plan designed at the Imperial Technical School of Moscow, Russia. The income of these scientific colleges is partly derived from the sale of lands allotted to them in each state; 30*l*. a year is charged to each pupil for tuition, but it represents but a small percentage of the income. The Cooper Union Free Night Schools of Science are well described as "an intelligent application of a great charity. Their purpose is the technical instruction of the labouring classes, and the means used are a free library and reading-room, free lectures, and two classes of schools, viz. the Evening Schools of Science and Art, and the Art School for Women. All money earned in the schools belongs to the pupil, and a number are thus enabled to support themselves while studying. A Telegraph Company has appointed a teacher in this school, who trains the pupils in their methods of working their instruments, and they have employed many of its graduates on their lines. Still the Report endorses the doctrine that even in technical schools, principles, not practice, must be the leading object of a school, and that even to those following a special business, a broad general culture is very important, and a want of it very much felt. After reviewing the various schools and institutions of this class in the United States, the Commissioner of Education is led to the conclusion that "the present condition of scientific and technical schools in our country is thus seen to be very promising. . . . Already they have excited the people to an appreciation of scientific methods and processes in their application to agriculture and the mechanic arts; and as the results of such methods are more widely known and more fully comprehended, the institutions rise in favour and influence, and the demand for their graduates increases."

Drawing is highly eulogised, and its importance insisted upon. In Massachusetts any town *may*, and every city and town having more than 10,000 inhabitants *shall*, provide for instruction therein; and a training school for teachers has been organised to meet their wants, with the result also of supplying designers to many manufacturers who were in want of them.

On the law schools in America, our Report observes that it is surprising that a profession which requires such thorough preparation, and which has in it so large a number of men of wealth, and one which occupies so important a place in the public affairs of the country, has done so little to endow its schools in the most substantial manner.

Medical men are very plentiful in the United States compared with other countries: 1 to every 600 inhabitants, while Canada has only 1 to 1200 inhabitants, Great Britain 1 to 1672, Germany 1 to 3000. A higher standard of examination is recommended, and an all-round education insisted upon. Only five schools at present require the highest amount of study to qualify a full practitioner.

A valuable branch of education is the training schools for nurses, which adopt a very high standard as to whom they receive for their important functions. A small sum, however, is *paid* to students, besides board and lodging, the latter of which is carefully provided them at a bright, cheerful home away from the hospitals where their duties are inculcated.

More than 30,000 blind people are among the population of the United States, and their education is considered, like other education, a duty and not a charity, and is provided out of national funds. Again, the education of the feeble-minded is systematically provided for, as being necessary for the prevention of crime, and useful to individuals of all classes. This leads on to the most important question in a country where population is thickening even as much as in America, of Reform Schools. There, under the Michigan system especially, which all should investigate, it seems fully realised that prevention is better than cure; and that while these inindustrial homes are indubitably powerful in preventing the formation of criminals, prisons, on the other hand, are just as indubitably powerful in carrying it on!

Evening High Schools have been worked in several American cities, but hardly with results lending much encouragement to increase. One would think, however, that the knowledge gained at elementary schools by the age of fourteen would lead to a wish for more on the part of many, to whom a library only could not supply it. But free libraries are a great power in the United States. Forty-nine new ones were opened in 1879, containing 86,779 volumes, making a total of 3842 public libraries of all classes. The correspondence with the Bureau of Education on the subject of public libraries far exceeds that on any other subject; academies standing next, and art and science standing curiously low for a country like America. Yet local feeling varies even on a favourite subject like free libraries, the large manufacturing town of Paterson being without one like so many populous English towns.

Like free libraries also, agricultural education is a department in which England, notwithstanding the height to which husbandry has been brought there, stands lower than in any other country.

One can hardly, nevertheless, read this Report without feeling that spite of our shortcomings the advantages are not all on the side of America. Our compactness, plentiful supply of thoroughly-trained teachers, and, we must add, higher sense of honour in political transactions, perhaps owing in part also to the close inspection to which the works of every man are subjected here, entitle us to feel how far better we are placed, as far as meeting educational requirements goes, than the thin and scattered families of the United States.

MALAYO-POLYNESIAN LINGUISTICS[1]

THE learned authors have earned the thanks of linguistic students by issuing, in a separate form, this important contribution to a better knowledge of the Melanesian and Papuan languages, which was first published in the eighth volume of the *Philological Transactions* of the Royal Saxon Scientific Institute. It forms the first instalment of a series of papers intended to supplement the comprehensive and well-known treatise of H. C. von der Gabelentz, published at Leipzig in 1860 and 1873. To the languages dealt with in that work are now added two others: that of Mafór (Núfór), Geelvinck Bay, and a dialect current on the Astrolabe Bay Coast, North-East New Guinea, from materials supplied by Van Hasselt and Miklucho-Maclay respectively. To these notices are added the Papuan idioms spoken in the islands of Errúb and Maer, Torres Strait, and in Segaar Bay, near Cluer Gulf, South-West Coast of New Guinea, the former by Herr Grube, the latter from data supplied by H. Strausch to the *Zeitschrift für Ethnologie*, viii., pp. 405-18.

In the introduction, the question of the relations of the Papuan and Malayo-Polynesian linguistic groups is discussed at some length. It is satisfactory to find that the authors seem at last disposed entirely to abandon the views held by the elder von der Gabelentz regarding a possible, if not probable, fundamental unity of these families. The key-note of the objection to this theory is struck in the following paragraph, at p. 4:—"Assuming that the linguistic affinity were fully established, we should have at once a direct antagonism between anthropology and philology. Two linguistic groups are related; of the corresponding ethnical groups, one belongs to one, the other to another race of mankind. How is this possible?"

To many this may seem merely an old-fashioned *a priori* argument, of no value in itself unless supported by the evidence of facts, which have hitherto pointed at an opposite conclusion. But one of the most firmly established and universally accepted principles of anthropology maintains the evanescent character of human speech as compared with the relative fixity of physical types. Ethnologists are of accord as to the substantial unity of the Iranian, Semites, Berbers, Basques, Georgians, and other members of the so-called Caucasic ethnical stock. Philologists are, on the other hand, equally of accord as to the essential difference of the Iranic, Semitic, Hamitic, Basque, Georgian, and other linguistic groups spoken within this common Caucasian ethnical group. Here we have fundamental racial unity combined with organic divergence of speech, and the apparent contradiction is readily reconciled by the doctrine of the far greater permanence of physical, as compared with linguistic types. The race, even notwithstanding the intrusion of foreign elemenrs, remains essentially one; the speech, presumably one originally, owing to its greater evanescence diverges in various directions to such an extent, that all traces of this original unity have long been effaced.

Coming now to the Oceanic area, where the Papuan and Malayo-Polynesian forms of speech, shown to be fundamentally one, while the physical forms are confessedly distinct, the case would be entirely reversed. Instead ot physical unity, combined with linguistic disparity, we should have the opposite phenomenon of linguistic unity combined with physical disparity. Such a phenomenon is certainly neither intrinsically impossible nor altogether unknown to science, as appears, from the Persian-speaking Házérahs and Aimaks of North Afghanistan, or the French and English-speaking negroes of the New World. But where they occur, such cases are easily accounted for by political supremacy, social contact, superior culture, and other obvious influences. These influences have also been to some extent at work probably for many ages in the oceanic world. The Malays in the west, and the brown Polynesians in the east, both of kindred speech, and both of roving or piratical habits, have in this way influenced numerous Papuan and Melanesian peoples in their respective domains. Hence we find the Tagalas, Bisayans, and even some of the Negrito Aetas of the Philippines, as well as some of the Negrito Samangs of the Malay Peninsula, and most of the Formosan wild tribes speaking various more or less divergent dialects of the organic Malay speech. In the same way the Papuan Motu tribe of the south-east coast of New Guinea, many of the Melanesian Fijians, New Hebrides, and Solomon Islanders are found to be now speaking various more or less divergent dialects of the organic Polynesian speech.

It was precisely from these misunderstood facts that philologists had generally arrived at the surprising conclusion that, in point of fact, the Polynesian and Melanesian languages were essentially one, thus placing anthropology and philology in antagonism. The Melanesian and Papuan dialects selected by Hans Conon von der Gabelentz, and again quite recently by the Rev. Mr. Codrington, as the subjects of comparison, were not, properly speaking, Melanesian languages at all, but Polynesian forms of speech imposed by the restless Samoans and other Polynesians on these Papuan and Melanesian populations. Obvious instances are the almost pure Papuan Motu people speaking a tolerably correct Samoan dialect (Rev. W. G. Lawes), and the mixed Melanesians of Fotuna, in the New Hebrides, speaking idioms closely related to the same group.

But it is remarkable that the reverse phenomenon has not yet been recorded. At least no instance is known to the writer of a distinctly Malay or Polynesian tribe speaking a distinctly Papuan or Melanesian tongue. It is more than doubtful whether such a case will ever be discovered in this watery domain, where the Malays and Polynesians

---

[1] "Beiträge zur Kentniss der Melanesischen, Mikronesischen und Papuanischen Sprachen," von G. von der Gabelentz und A. B. Meyer. (Leipzig, 1882.)

have always been the aggressors, where the dark populations have always represented the passive or recipient element. On the other hand, wherever it has escaped from Malayo-Polynesian influences, or wherever it has been able to preserve its original speech in spite of those influences, this dark element will certainly be found speaking languages organically distinct from the Malayo-Polynesian. Mr. Man's recently published account of the Andamanese dialects shows that they differ in their morphology, in their glottology—in fact, in every respect, from those of Malaysia.

Mr. Lawes makes the same remark respecting the Koiari people, who occupy the highlands back of Moresby Bay in South-East New Guinea. And the authors of the work under review now find that the Mafór of Geelvinck Bay betrays, with many striking resemblances to the Malayo-Polynesian, "an astounding peculiarity of structure."[1] The "resemblances" are of a verbal character, due to known contact with the Malays, who have long frequented the waters along the north-west coast of New Guinea. The "peculiarity of structure," involving root modifications and something even approaching to inflection ("Quasiflexion"), as understood in the Aryan family, belongs to the organic Papuan linguistic type. This type is thus demonstrated to be fundamentally distinct from the Malayo-Polynesian, which shows no trace of these peculiarities. And thus also disappears the fancied antagonism hitherto supposed to exist between the linguistic and anthropological elements in the Oceanic regions.

A. H. KEANE

THE SOLAR-COMMERCIAL CYCLE

IN an article printed in NATURE (vol. xix., pp. 588-90) I gave a table of the prices of wheat at Delhi, from 1763 to 1835, quoted, or rather calculated from data given in a brief paper of the Rev. Robert Everest, contained in the *Journal* of the (London) Statistical Society for 1843, vol. vi. pp. 246-8. Between the years 1763 and 1803 there was evidence of wonderful periodicity in the recurrent famine and abundance at that part of India. When recently engaged in examining more minutely the relation between these prices and the variations of solar activity, as indicated by Prof. Wolf's numbers, it has occurred to me that an inference may be drawn which I overlooked on the previous occasion.

In the accompanying diagram I have exhibited the prices in question together with Wolf's numbers as stated in the *Monthly Notices* of the Royal Ast. Soc. vol. xxi. pp. 77, 78. I have also indicated the dates of the Commercial Crises of the time according to the article on the subject in Mr. H. D. Macleod's "Dictionary of Political Economy," vol. i. pp. 627-8. It need hardly be said that the coincidence between the three classes of recurrent phenomena is of a very remarkable character, and goes far in supporting the relation of cause and effect which I had inferred to exist, both on empirical grounds and from the well-known fact that it is the cheapness of food in India, which to a great extent governs the export trade from England to India. But although the coincidence of commercial Crises in Western Europe with high corn prices at Delhi is almost perfect, it will be noticed that after 1790, the correspondence of the solar curve with that of prices is broken. Wolf does not recognise the existence of any sun-spot maximum between 1788 and 1804, and he believes that there was a minimum at 1798. According to Wolf's later researches (*Memoirs* Roy. Ast. Soc., vol. xliii. p. 302), these dates are respectively, maximum 1788·1, minimum 1798·3, and maximum, 1804·2.

But now arises the question to which I wish to draw attention. If the eleven-year solar periodicity was really interrupted in this long interval of 16·1 years, how comes it that the meteorological periodicity, as manifested in the corn prices at Delhi, was not interrupted. It is true that the price maximum of 1803 was a comparatively small one; but this was quite to be expected, considering that if there were an intervening solar maximum, it must have been a small one. May we not reverse the argument and infer that the evident relation between the previous sun-spot maxima and the succeeding scarcities at Delhi, would lead us to expect a minor solar maximum about the year 1797?

Standing alone, the presumption thus created would, doubtless, be of a somewhat slight character. But it is in the first place well known, that the data upon which Wolf based his numbers about this time, are less conclusive than in other parts of his series. His results, too, from 1801 to 1807 are expressly marked as doubtful, so that extrinsic information which might have little weight where there was abundance of reliable solar or magnetic observations may come in very usefully where doubts already exist. Now it happens that the late Mr. J. A. Broun inquired very carefully into the facts known about the solar variation at this time, his results being given in the *Transactions* of the Royal Society of Edinburgh, vol. xxvii. pp. 563-594, and in his article printed in NATURE (vol. xvi. pp. 62-64). Broun inferred from the observations of Gilpin, and from other data, that there was a small maximum about 1797, and that there were grounds for believing that the subsequent maximum "may really have occurred after 1806, when Gilpin's series terminated." Now, what Broun deduced from totally different data, is exactly what we should infer from the Delhi prices. If we are to believe that Indian meteorology depends upon solar variations, then it almost follows that there was a solar maximum about 1797. The consequence of this inference, however, is very important, because it goes to support the views of Lamont, Broun and others, that the solar period is about 10½ (10·45) years and not 11·1 as calculated by Wolf. It should also be pointed out that the temperature observations of Prof. Piazzi Smyth lead to a like result. The epochs of the heat waves are, according to him (NATURE, vol. xxi., p. 248), 1826·5, 1834·5, 1846·4, 1857·9, and 1868·8, giving an average interval of 10·57 years.

I may take this opportunity of asserting that the progress of events confirms belief in the eastern origin of the great commercial Crises.[1] In his important work, the "Précis du Cours d'Economie Politique" (vol. i. pp. 604-5), M. Cauwès while partially accepting the doctrine of periodicity criticises the particular views here advocated. He says:—

"Depuis longtemps les économistes ont signalé la périodicité de ces évolutions : MM. Juglar et Jevons prétendent même pouvoir la calculer d'une manière précise. Selon M. Jevons, l'ensemble des phénomènes serait renfermé dans un cycle de dix années et demie. De fait, les grandes crises économiques du siècle (1806, 1817, 1825-7, 1836-37, 1847, 1857,) s'échelonnent à dix années d'intervalle ou à peu près, mais les dernières, 1866 et 1873, seraient venues un peu avant l'heure, et celle de 1873 s'est prolongée au delà de toute attente." M. Cauwès in short accepts the six earliest crises of this century as sufficiently agreeing with the theory. The crisis of 1866 no doubt came about a year before it would be expected, which is a divergence of reasonable amount. The year 1873, however, is one which it would be impossible to introduce into the series. Now there doubtless were both in America and England in that year, a state of commercial stringency, a relapse of prices and other disturbances which might be mistaken for the signs of a

---

[1] "Gerade das Mafoor'sche aber wird in seinem Baue bei manchen auffälligen Aenlichkeiten eine erstaunliche Eigenthümlichkeit im Bildungsprinzipe aufweisen," p. 4.

[1] As it is impossible to reproduce the explanations and qualifications contained in the article quoted above, or that at pp. 33-37 of the same volume of NATURE (vol. xix.), it is assumed that this article is read subject to those qualifications and explanations. In p. 588 col. *b* of the same volume, a *seer* of wheat was by a typographical oversight stated to be equal to 21 lbs. instead of the true weight 2 lbs.

true crisis. But such as it was, this crisis turned out to be just one of those exceptions which prove the rule. The following statistics of bankruptcy in the United Kingdom, as collected by Messrs. Kemp, and published in the *Mercantile Gazette*, show conclusively that the real collapse came in exact accordance with the decennial theory in the autumn of 1878 or early in 1879:—

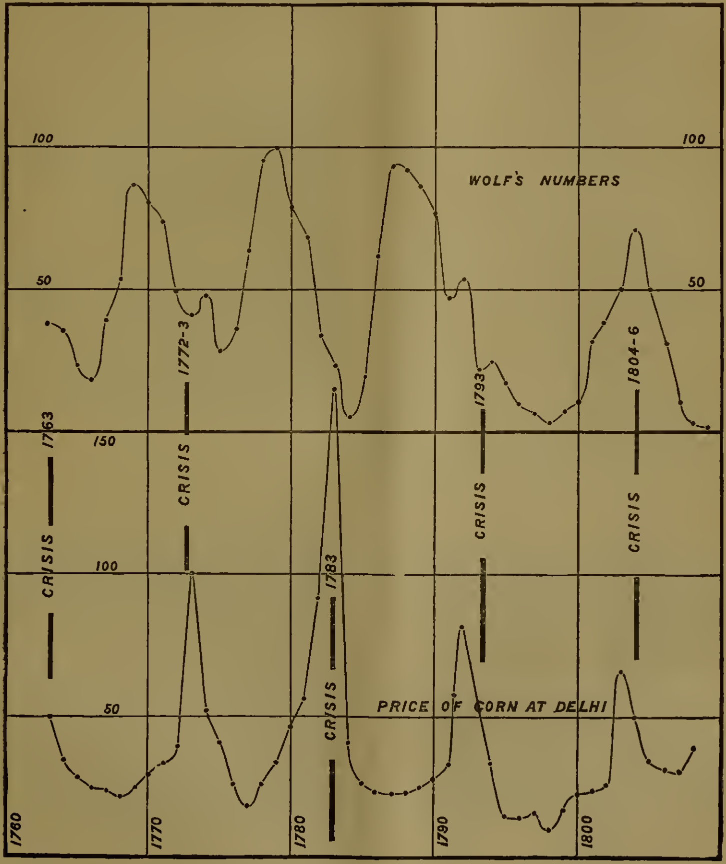
Year.	Number of bankruptcies.	Year.	Number of bankruptcies.
1870	8,151	1876	10,848
1871	8,164	1877	11,247
1872	8,112	1878	13,630
1873	9,064	1879	15,732
1874	9,250	1880	12,471
1875	9,194	1881	11,632

It will be remembered that the crisis of 1878 was precipitated by the failure of the City of Glasgow Bank owing to great losses of their customers in the Indian trade, the depression of that trade being caused by the recent famine in India.

As a good deal of misapprehension has arisen concerning the American Crisis of 1873, it is well to quote the following valuable statistics from the Annual Circulars of Messrs. R. G. Dun's mercantile agency:—

Year.	Number of failures.	Amount of liabilities in dollars.
1873	5,163	228,589,000
1874	5,830	155,239,000
1875	7,740	201,060,353
1876	9,092	191,117,786
1877	8,872	190,669,936
1878	10,478	234,383,132
1879	6,658	98,149,053
1880	4,735	65,752,000
1881	5,582	81,155,932

Although the amount of liabilities involved in the failures of 1873 was larger than in any subsequent year except 1878, the number of failures was less than in any year named except 1880. The average liability of each failure in 1873 was $44,274 compared with $22,369 in 1878. It is thus apparent that the crises differed entirely in character, and I believe that the collapse of 1873 was mainly due to the breakdown of values of properties necessarily following sooner or later upon the contraction of the paper



currency. In any case there was a very distinct maximum of failures in 1878, succeeded by a sudden reduction, and it occurred at a time differing by less than a year from the corresponding collapse in England. In the Dominion of Canada there was a very strongly marked maximum of failures at the same time as in England, namely, in 1879.

The theory of the solar-commercial cycle and of the partially oriental origin of decennial crises has received such confirmation as time yet admits of. I am, however, fully alive to the weight of some of the difficulties and objections which have been brought forward against the theory. These objections are far from being conclusive, and I may hope to give them in due time a satisfactory answer. But such answer must involve more detail than can be put into a brief article.

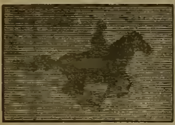
W. STANLEY JEVONS

CONVENTIONAL REPRESENTATION OF THE HORSE IN MOTION

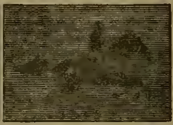
IT is of interest to analyse the reason why artists represent a galloping horse in a way unlike any of its real attitudes, as they have been photographed by Mr. Muybridge, and why the critical public have so long acquiesced in these incorrect representations without remonstrance. Partly, no doubt, it is owing to prevalent errors of conception which govern the judgment in its interpretation of a movement that is hard to follow. An excellent instance of this is to be seen in the Academy, in the diploma picture of Mr. Riviere, R A., entitled "The King drinks." It is a lion lapping water in the wrong way, by spooning his tongue outwards and upwards instead of curling it backwards, like the fingers of the half-closed hand when the knuckles are to the front, an action that may be conveniently studied in the kitten. The error of preconceived ideas partly explains the conventionally extended figure of the galloping horse; but I find the latter to be largely justified by the shape of the blur made on the eye by his rapid and various movements. I wish I could reproduce on a scale, however small, any one of the many plates published in "The Horse in Motion;" but it appears that the copyright of the photographs is disputed, and there are difficulties in the way of doing so, and I must make shift without them.

I find that taking the attitudes of the galloping horse, Phryne, as an example, published in Plate XVI. of the book just mentioned, that her stride has the duration of about six-tenths of a second, and that it has been photographically analysed into twenty momentary attitudes. Also, that these may be arranged in four groups, which I will call A, B, C, and D. I have made photographic composites of each of these groups, and copies of them by the wood engraver are annexed.

A



B



C

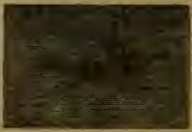
D

A contains six attitudes, in which the legs are crumpled below the body.

B contains four attitudes, in which one or both of the hind legs are on the ground, and the fore legs are pawing in the air.

C contains five attitudes, in which both the fore and hind legs are extended.

D also contains five attitudes; the hind legs are flung back and the fore legs are on the ground.



G

G is the general composite of all the attitudes.

FIG. 1.

FIG. 2.

It will be observed that in the general composite the blur somewhat justifies the conventional representation, because though the lower parts of the limbs leave no definite image at all (less so in the photograph than in the engraving), the upper portions have a distinctly outflung look, and as the artist lies under the same unhappy necessity that plagues the geographer, who, when he has to put down a lake or river on the map must put it *somewhere*, although its real position may be uncertain, so the artist thinks he must put the lower parts of the four legs of the horse somewhere, and he is guided in his decision as to the exact place by the direction of their upper portions.

I find, however, on trial that another cause of confusion lies in the difficulty of watching closely both the fore and the hind halves of the animal simultaneously. The eye wanders from one to the other and seizes the most characteristic attitudes of each, and combines them into a hybrid monster.

The accompanying composites, Figs. 1 and 2, each from four successive attitudes, will explain the process; it certainly tends to go on in my mind, and probably does so in that of others. The first composite shows the hind legs distinctly; the second shows the fore legs distinctly; and if duplicates of the first and second woodcuts are each divided in two halves and the best defined half of each are united (in a way that might have occurred to Baron Munchausen if a second rider's horse had suffered as his own, and there had been a mistake in piecing them), a result, Fig. 3, is produced that shows a very fair correspondence with a not uncommon representation in sculpture.

FIG. 3.

FRANCIS GALTON

THE CHANNEL TUNNEL

AT the meeting of the Paris Academy of June 26, M. Daubrée read a note on the geological conditions of the Channel tunnel. The works connected with the tunnel comprise three phases:—(1) Scientific researches; (2) preparatory works; (3) execution of the tunnel itself. The first phase was devoted to purely geological investigation, in the form of minute exploration of the French and English coasts, exact and detailed investigation of the sea-bottom in the Strait, borings made on *terra firma* which verified the nature, thickness, and inclination of the strata, and gave an approximate idea of the hydrological condition. Since 1879 the second phase has been entered on by verifying the previous scientific data, and preparing for the execution of the tunnel itself, experimenting in small galleries with machines and tools capable of being ultimately used in a work of exceptional importance. On the French coast, the geological investigation established a slight bulging of the beds at the place known as the *Quenocs*. On account of this bulging the inclination of the strata, which, in the strait is towards the north-north-east, is found, along the cliffs of Blanc Nez, turned towards the south-east, and the slope which, according to the first orientation, in the neighbourhood of the Quenocs, is about 0·05 m. per metre, is found, in the second, to be nearly 0·09 m. It is important then, to find in what conditions this bulging may modify the physical conditions of the banks forming the base of the Rouen chalk. For this purpose the French Association had dug, near Sangatte, two shafts of a depth of 86 m., which met the gault at 59 m. below the hydrographic zero, adopted in the maps in which the geological explorations of 1875-6 are recorded. The digging of these shafts, one of them 5·40 m. in diameter, showed that all the white chalk and the upper part of the Rouen chalk are water-bearing. These strata had thus to be abandoned.

On the other hand, the base of the Rouen chalk allowed only a very small portion of water to pass. There, then, the tunnel should be pierced, as the stratum appeared to proceed without interruption from France to England. The water penetrating the works is fresh, and of good quality; at the upper part only some slightly salt veins were found. Nevertheless, the communication of the water-bearing strata with the sea is proved by the oscillation of the water-level in the shafts according to the tide, and by the invariable increase at high water. M. Daubrée then refers to further galleries dug on the French and on the English sides, and excavations made with the machines of Col. Beaumont and Mr. Brunton On the Dover side, the chalk, which on the French side was but little permeable, was, on the English side, quite impermeable. Owing to this circumstance, they were able to begin at the bottom of the shafts, at 29 m. below the French hydrographic zero, a gallery advancing under the sea by following in the stratum an almost regular descending slope of 1-80th, or 12·5 mm. per metre. The bed on the English side, somewhat more powerful than on the French side, presents a very great regularity. Thus the Beaumont machine, which has been used in the perforation, has been easily able to trace a perfectly cylindrical gallery, which has now reached 1800 metres from the shafts, of which 1400 metres are under the sea. So far there has been no access of water. In the banks which form the base of the Rouen chalk, the rock in mass is almost completely dry; the access of water which has been observed has entirely the character of small springs issuing from the joints of fracture or cleavage. The perfectly cylindrical form produced by the Beaumont machine renders the gallery where such leakage occurs easily isolated by means of cast-iron rings prepared in segments easily united, the rings themselves being clamped together to form a tube of any length. When the water spurts out in considerable force, a sort of mastic or minium is successfully employed, which is placed between the segments of the rock, and compressed in the manner of a water-joint by the pressure of the rings against the rock. The mastic also seems to render the joints of the neighbouring rings water-tight. Owing to the excellent make of these rings, they can be rapidly put in position; a complete ring can be placed in half-an-hour, and several experiments in the Shakespere Cliff Gallery have proved that by this simple process the springs encountered can be completely blocked. On account of the slope on which the English gallery descends, its extremity recently reached 51 m. below the hydrographic zero, at a point where the depth of the sea at low water is 5 m.; there is thus 46 m. of chalk between the floor of the gallery and the bottom of the sea.

NOTES

MR. GEORGE GRAY, Honorary Secretary of the Philosophical Institute of Canterbury, Christchurch, New Zealand, writes under date May 20:—"I have been requested to forward you the inclosed resolution passed at a meeting of this Institute May 4, 1882, and to ask if you would kindly insert the same in the Notes of your valuable journal. Resolution proposed by C. Chilton, M.A., seconded by G. Gray and carried:—'That this Institute desires to place on record its high appreciation of the great services that have been rendered to science by the late Dr. Charles Darwin, and its deep sense of the loss that science has sustained through his death.'"

AT a meeting of the Executive Committee of the Darwin Memorial Fund, held on June 30 at the Royal Society's Rooms, Burlington House, it was announced that the total subscriptions already promised or received amounted to £2487 13*s*. It was decided that the memorial should take the form of a marble statue; and a sub-committee was appointed to make the necessary arrangements. It was agreed to ask the trustees of the British Museum for permission to place the statue in the large hall of the British Museum (Natural History), South Kensington. The sub-committee consists of the following:—Mr. W. Bowman, Sir J. D. Hooker, Prof. Huxley, Mr. C. T. Newton, and Sir F. P. Pollock, with the Chairman, Mr. W. Spottiswoode, Pres. R.S., the Treasurer, Mr. John Evans, Treas. R.S., and the Hon. Secretaries, Prof. Bouney and Mr. P. Edward Dove.

WE would draw the attention of our readers to a letter which we print this week from Dr. Sophus Tromholt, relative to the establishment of an observatory in Sweden for the Aurora Borealis "and other phenomena of Terrestrial Magnetism." Dr. Tromholt, it will be seen, is anxious to obtain for his proposal the opinion and advice of those familiar with the subject. Doubtless some of our readers might in this matter render useful help.

IN the sitting of the Paris Academy of Science of July 2, M. Berthelot, who had crossed the Channel with M. de Lesseps to visit the English works of the Channel Tunnel, gave an enthusiastic description of the galleries excavated at Dover, and the working of the Beaumont machine.

DR. ZIEGLER of Freiburg has recently prepared five wax models illustrating the development of the head of *Sinedon pisciformis*, *Salmo salar*, and *Rana temporaria*, founded upon the investigations of Dr. Ph. Stöhr of Wurzburg. These models are likely to be of great service to students in mastering the development of the skull, being greatly superior for this purpose to the best diagrams. The price of the series, conveniently packed in two boxes is 55 marks.

THE splendid dining-room and picture-gallery, together with the grand staircase of Stafford House, the residence of the Duke of Sutherland in Mayfair, have now been fitted up with the incandescent electric light. The lamps are those of Lane-Fox, as supplied by the British Electric Light Company, and the arrangements have been made by Mr. W. Mackie, who has been entirely successful in producing a fine effect. There are about 250 lamps displacing 8000 wax candles, and they are fed by the current from six Gramme machines of B type. The field magnets of these machines are excited by the current from two E Gramme machines, it being found preferable to adopt this plan. The power is derived from a 20 H.P. (nominal) steam-engine built by Marshall. The lamps are all in parallel circuit, so that the total resistance of the lighting circuit, including leading-wires of copper, is only 0·6 ohms. The leads consist of copper strand wires ⅞th of an inch in diameter, properly insulated and protected. The pure character of the incandescent light, together with its sanitary and artistic advantages, is causing it to make its way in West-End mansions.

A SPECIAL meeting of the Anthropological Institute will be held at No. 4, Grosvenor Gardens, S.W., the residence of Gen. Pitt Rivers, F.R.S., the President of the Institute, on Tuesday, July 11, at half past eight o'clock, p.m., when the following papers will be read:—1. Note on the Egyptian Boomerang, by General Pitt Rivers, F.R.S., President. 2. On the Longevity of the Romans in North Africa, by the Right Hon. Lord Talbot de Malahide, F.R.S., President of the Royal Archæological Institute. 3. On Neolithic Stone Implements, &c., from Wásá on the Gold Coast, by Capt. R. F. Burton and Commander V. L. Cameron, R.N., C.B. 4. Exhibition of Bushman Drawings, by Mr. M. Hutchinson, with Note by Mr. W. L. Distant.

THE Anniversary Meeting of the Sanitary Institute will be held in the Royal Institution Theatre, Albemarle Street, on Thursday, July 13, at 3 p.m. An address will be delivered by Edward C. Robins, F.S.A., F.R.I.B.A., entitled: "The Work of the Sanitary Institute of Great Britain." The chair will be taken by His Grace the Duke of Northumberland, K.G., President of the Institute.

THE late Dr. Karl Remeis has left a sum of 20,000*l*. to found an astronomical observatory in his native town of Bamberg, Germany. He has besides given the future observatory a 10-inch refractor and several other instruments.

THE great summer excursion of the Geologists' Association will be this year to the West Riding of Yorkshire, on July 17 and five following days.

FROM the *Scotsman* we learn that H.M. ship *Triton* arrived at Granton on Sunday week from Sheerness, where she had been fitted up for the prosecution of deep-sea investigations. The steamer is commanded by Staff-Commander Tizard. At the request of the Royal Society, the *Triton* has been detached for two months to investigate certain questions of physical geography in the Faroe Channel, which have a bearing on the results of the *Challenger* Expedition. On Monday week the vessel was supplied from the *Challenger* office in Edinburgh with dredging and sounding gear, deep-sea thermometers, and other apparatus. Mr. Murray and his assistants are to join the vessel at Stornaway in the course of three weeks; and she will be engaged for about six weeks in investigating the Faroe Channel. After completing this work, the *Triton* is to come into Oban to take on board Prof. Tait, and convey him to the North Atlantic, where, in a depth of 2000 fathoms, he proposes to test certain experiments which he has been performing on the *Challenger* deep-sea thermometers. (See NATURE, vol. xxv., pp. 90, 127.) In regard to the proposed Faroe expedition, it may be remembered that an exploration of the channel in question was made by Staff-Commander Tizard and Mr. John Murray, during the summer of 1880, in H.M.S, *Knight Errant*, the results of which were recently submitted by Mr. Murray to a meeting of the Edinburgh Royal Society. On that occasion Mr. Murray referred to the discovery by the *Lightning* and *Porcupine*, in 1868-9, of two contiguous areas having widely different bottom-temperatures, called by Dr. Carpenter the cold and warm areas respectively. At that time, he said, there was no suspicion of the existence of a sub-marine ridge separating those two areas. Certain theoretical considerations, however, based on some of the general results of the *Challenger* expedition, induced Commander Tizard to express the opinion that these two areas were separated by a ridge rising to within 200 or 250 fathoms of the surface. When a divergence of temperature was observed at some distance above the bottom in adjoining areas, it was inferred that a ridge intervened, and that the point of divergence indicated the height of the ridge. It was to make soundings in reference to this question that the *Knight Errant* was detached (see NATURE, vol. xxii. p. 405). Referring to the probable limitation of the British fauna, Mr. Murray remarked that since the depth limit had been disproved by the finding of animals at all depths, an artificial limitation must be substituted, and he thought it would be a temperature limit, for Arctic, British, and deep-sea species were obtained by the *Knight Errant*. There were climates on the surface of the sea, as well as on land, each having its peculiar fauna, and this surface fauna could be traced on the bottom by the dead shells found in the deposit.

FROM the Cape of Good Hope we receive the Report for 1881 of the South African Museum, which, under the superintendence of Mr. Trimen, is prospering and increasing. The following paragraph is of some interest:—"Upon trustworthy information that in a part of the Beaufort West district some unusually fine and perfect remains of extinct Saurians were accessible, the Trustees in October last despatched the Acting Curator to make an examination on the spot. Mr. Oakley reported that he had met with a large quantity of fragmentary remains of the *Dicynodon* group (some of which he brought with him), and that he had reason to believe, from the best local information obtainable, that in the bed of the Klein Leeuw River there existed an almost perfect fossil skeleton of a Saurian of great size, which, though recently visible, had become hidden by alluvial deposits. In transmitting this report to Government on November 1, the Trustees strongly recommended that a sum of 200*l.* should be placed on the estimates for 1882-83, for the purpose of defraying the cost of procuring for the Museum the more perfect of these fossil remains, and of conducting further investigations into South African palæontology; and they were informed in reply that every consideration would be given to their proposal when the time for framing the estimates should arrive. In reference to their subsequent communication on the subject, dated February 9, they now desire respectfully to renew their recommendation, as it is most desirable that the extinct *Dicynodontia* and allied reptilian forms, so characteristic of the past life of South Africa, should be as completely represented as possible in the Colonial Museum." We trust the necessary funds have been granted, and that the Trustees will see that it is for the best interests of the Colony that such an institution as this be maintained in complete efficiency.

THE surveyor to the Finnish Government, Herr Rodas, states that on June 25 this year he carefully measured the height of a hole, bored according to authentic records 2 inches above the level of the sea on the coast of Österbotten on June 25, 1755, and discovered that that part of the coast had risen, in 127 years, 6 feet 4 inches, or more than half an inch per year.

A SECOND earthquake of a far more violent character than the previous one, was felt at the town of Luleå in Sweden on June 23 at 7.30 a.m., the shock extending as far as the towns of Haparanda and Pitia. It lasted fully a minute, and went from south-west to north-east. People awoke from their sleep, and those about could only stand with difficulty, and that no accident occurred is due to the circumstance that all houses are constructed of wood. Whilst the tremor lasted subterranean noises could be heard similar to the rapid movement of heavy artillery on a hard road. There was no disturbance of the sea, the weather was clear and no wind, the temperature being 20° C., barometer high.

THE Parkes Museum, which was first instituted in 1876 as a memorial to the late Dr. Edmund Parkes, and in order to promote the health of the community for which Dr. Parkes so successfully devoted the best years of his life, was incorporated on June 28. The museum has been temporarily located in University College, Gower Street, since its establishment, and a proposal for permanently keeping it in connection with the College has been under consideration for some time, but the probability is that those who desire to see the Parkes Museum established as an independent institution in a building of its own will have their wishes gratified. Negotiations are now being made for acquiring such a building in a more central position than University College. The Museum is not rich pecuniarily, but its objects are of such growing importance that the necessary funds will no doubt be forthcoming. The objects of the Museum are "to aid, promote, and encourage the acquisition and diffusion of knowledge of hygiene in all its branches, and of all matters relating thereto, especially in connection with personal *régime*, food, domestic sanitation, means of safety and rescue, architecture, engineering, naval and military hygiene, and State medicine.

WE regret to notice that the Austrian Polar Meteorological Expedition has not been able, on account of the state of the ice, to land on Jan Mayen Island. The *Pola* put back to Tromsö, and was to make another attempt after fourteen days; we hope she will be successful.

AN International Geographical Exhibition is being held at Copenhagen.

THE French expedition to Cape Horn will leave this week without any further delay.

LIEUTENANT SCHWATKA is organising an expedition for the exploration of Northern Alaska.

THE Report of the Imperial Mint, Ôsaka, Japan, for the year ending June 30, 1881, being the eleventh report of the Mint, shows that during the financial year gold coins to the value of 490,585 yen (dollars) was struck, this being rather more than during the previous year. In the silver coinage there has been great activity, 5,089,113 one yen pieces having been struck, this being a larger number than ever before finished in a year. Nearly 74 millions of copper coins were struck during the year, their aggregate nominal value being over one million yen. The total value of coin issued by the Imperial Mint since its commencement in 1871, to July, 1881, amounted to yen 97,596,529,·79. The reports of the Assayers to the Imperial Japanese Mint, of the Royal Mint, and of the United States Mint, testify to the highly satisfactory manner in which the standards of weight and fineness are kept up. The soda-works within the Mint-ground are now in operation, and small quantities of sulphate and carbonate of soda have been turned out. The sulphuric acid-works did not produce so large a quantity of acid as in former years, but another works has been established in Osaka by a private company, showing that chemical industry in Japan is not standing still. The work carried on at the Osaka Mint, both as regards quantity and quality, is in the highest degree creditable to the two foreign *employés*, Mr. Gowland, the chemist, assayer, and technical adviser, and Mr. McLagan, the engineer, as well as to the staff of native officials and workmen.

CAPTAIN CONDER and Lieutenant Mantell, R.E., have returned from their first campaign in Eastern Palestine, bringing with them the results of their work. These include the map of a large district, covering 500 square miles of country, with a very large quantity of notes, plans, drawings, and photographs concerning the antiquities of Moab and Gilead. Captain Conder will proceed at once to arrange these materials for publication. He has also brought with him a considerable quantity of notes, and additional information made by himself and his party in Western Palestine. These will be included in the next volume of the Society's great work, which will be delayed a month or two on their account.

THE Municipal Council of Paris has voted a sum of 40*l.* as a subsidy to the Academy of Aërostation for the purpose of trying to photograph Paris with the help of captive balloons.

THE July number of the *Proceedings* of the Royal Geographical Society is of unusual interest. Along with excellent maps we have Mr. D. D. Daly's account of the surveys and explorations in the native States of the Malayan Peninsula, 1875-82; a translation of Dr. Albert Regel's account of his journey in Karateghin and Darwaz; and some interesting details as to Capt. P. de Andrada's journeys to Masinga and the Mazoe on the Lower Zambese. This number contains the report of the anniversary meeting.

A WELL-ATTENDED meeting was held last week to consider the desirability of presenting a testimonial to Mr. Ernest Hart in recognition of his eminent public and professional services. It was unanimously resolved that an appeal for subscriptions should be made to the medical profession and the general public in support of this movement. It was agreed that the testimonial should take the form of a portrait of Mr. Ernest Hart, to be presented to Mrs. Ernest Hart. It was announced that already over 100 influential members of the medical profession had expressed their desire to contribute to the fund. Mr. Spencer Wells was appointed treasurer, Mr. Arthur Myers, surgeon to the Coldstream Guards, and Mr. Noble Smith (24, Queen Anne Street, W.), were appointed hon. secs., and an executive committee, with power to add to their number, was appointed.

IN a recent communication to the Vienna Academy, Dr. Paulsen has described a singular series of experiments with reference to the course of air in the nasal cavity in breathing. Conclusions as to this path have been drawn from structure, but Dr. Paulsen adopted the method of lining the nasal cavity in the head of a dead body with small pieces of red litmus paper, and then causing ammoniacal air to be inhaled and exhaled through the windpipe. The changes of colour in the paper proved that the expiratory and inspiratory currents take nearly the same course, and that the main portion passes, not through one of the nasal passages, but along the septum in an arching course, convex above. The course of air-currents was investigated under varying conditions of ventilation, &c., also the behaviour of secondary cavities. Some old and new experiments on the act of smelling are explained on the basis of the facts elicited.

FROM the woody tissue of some plants (according to recent researches by Herr Max Singer, Vienna) four substances can be extracted by means of hot water: 1. Vanillin, which seems to be one of the most widely distributed plant-substances; it is found even in decayed wood and in brown coal. 2. A substance which shows the reactions of coniferin. 3. A species of gum soluble in water. 4. A substance soluble in water, and coloured yellow with muriatic acid, not identical with any of those already specified. Moreover, woody tissues (also elder pith) contain the wood gum discovered by Thomson. In what relation these substances stand to the hypothetical lignine is not determined, but the way in which they can be separated from the wood, one after another, by water, renders it probable that what is called lignine is a mixture of several chemical entities.

THE Academy of Sciences has nominated M. Bertrand as its representative at the inauguration of the Fermat statue, which will take place on August 20 next, in a small country town of Tarn-et-Garonne, where this illustrious mathematician was born, at the beginning of the 17th century.

THE additions to the Zoological Society's Gardens during the past week include a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Messrs. L. and J. Boljhon; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mrs. Norris; two Tovi Parrakeets (*Brotogerys tovi*) from Columbia, presented by Major Langford Brooke; two Uvean Parrakeets (*Nymphicus uvæensis*) from Uvea, Loyalty Isles, a New Zealand Parrakeet (*Cyanorhamphus novæ-zealandiæ*) from New Zealand, presented by Mr. E. L. Layard, H.B.M. Consul, New Caledonia; an American Robin (*Turdus migratorius*) from North America, presented by Col. Verner; a Yellow Wagtail (*Motacilla flava*), a Marsh Tit (*Parus palustris*), British, presented by Mr. H. Grant; four Speckled Terrapins (*Clemmys guttata*) from North America, presented by Mr. C. D. Ekman; a Common Snake (*Tropidonotus natrix*), British, presented by Mr. Poyer Poyer; nine Fire-bellied Toads (*Bombinator igneus*), a Lacertine Snake (*Cœlopeltis lacertina*), a Back-marked Snake (*Rhinechis scalaris*), European, presented by Mr. G. A. Boulenger; a —— Newt (*Notopthalmus viridescens*), from America, presented by Messrs. Sargent; an Undulated Grass Parrakeet (*Melopsittacus undulatus*) from Australia, deposited; a Canada Goose (*Bernicla canadensis*), British, a Sharp-nosed Crocodile (*Crocodilus acutus*) from Central America, purchased; two Geoffroy's Doves (*Peristera geoffroii*), bred in the Gardens. The following insects have emerged during the past week:—Silk Moths: *Actias selene*; Moths: *Hypochera io*, *Ceratocampa imperialis*, *Deilephila vespertilis*, *Deilephila euphorbiæ*, *Sciapteron tabaniformis*, *Sesia museæiformis*, *Sesia empiformis*, *Zygæna filipendulæ*, *Plusia concha*; Butterflies: *Apatura iris*, *Vanessa polychlorus*, *Lycænia iolas*, *Aporis erabægi*.

DISTRIBUTION OF AWARDS, NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOL OF MINES

THIS took place in the Lecture Theatre of the South Kensington Museum on Saturday, June 24. The Vice-President of the Committee of Council on Education, the Right Hon. A. J. Mundella, M.P., took the chair.

Col. Donnelly, after some introductory remarks, said:—In the report of the school, which you have before you, Sir, there is a paragraph from which some people might possibly imagine that the necessity for training teachers in science was not thought of when the general scheme of aid to science instruction was considered and promulgated in 1859, and that it was not until that scheme had been in operation for a few years that the necessity for training science teachers came to light. Now, Sir, I was present at the deliberations which took place on the framing of that Minute of 1859, and although it is a long time ago I have a very distinct recollection of all that occurred.

But I would here wish for one moment to digress, and recall the memory of a remarkable man who was deeply connected with those deliberations, and to whom they owe so much. He has but recently been taken from us, and though Sir Henry Cole had for several years ceased his connection with this institution, I am sure it needs no excuse from me that on this, the first public ceremony which has taken place since his death, I recall to you for one moment his memory. We cannot but all remember how much this place, and science and art instruction, I mean of course elementary science and art instruction, owe to Sir Henry Cole. No one would be so foolish as to suppose that even if Sir Henry Cole had not lived and worked we should not at the present time have had a system of elementary science and art instruction in the country; but it is given to a few men here and there, now and then, to have a clear view before them, and to have that energy and indomitable perseverance, which enables them, as it were, to put on the hands of the clock, and to impress a form and reality on what in the hands of other men would probably have remained vain imaginings. Sir Henry Cole was such a man; and no one who, like myself, worked for some fifteen or sixteen years under him, could fail to be impressed with that remarkable personality; with his boundless sympathy in all progress and work; and with his extraordinary *vis viva* which communicated some at least of his zeal and devotion to all who came in contact, and were working, with him.

Well, Sir, to recur to the deliberations with regard to the Minute of 1859; numbers of educational doctors were consulted; they all proposed, and I believe it was about the only suggestion in which they all agreed, that the first thing to be done was to establish a system of training teachers at some central institution, such as the School of Mines in Jermyn Street, which when it was first established had that object in contemplation. Fortunately—most fortunately—that advice was not followed. You will remember, Sir, that a noble lord, your predecessor in the office you now hold, has been somewhat twitted with prophesying something with regard to the steam-ploughs in Asia Minor. The day will no doubt come, when his lordship will have the laugh of the scoffers. But a cargo of steam-ploughs in Asia Minor at the present moment would be a no more hopeful consignment than a number of trained teachers issued from a central establishment, to make their living by science instruction, would have been in 1859. We had to trust to a much ruder implement, if I may say so, and we had to trust to that local implement being brought out and set in motion by a system of payments by results, and right well many of those local teachers have done their work. I should remind you, sir, that the system of paying on results, which has had so large a development since in various directions, was first tried here. This is not, however, the occasion for discussing the general system of science instruction, and science payments, and I only advert to it at the present moment to call attention to what has grown out of it to supplement it, and that is the arrangement for bringing science teachers from the country up to London for short courses of instruction in the summer. That is a system which I believe obtains in no other place or country; I believe it is most invaluable. This point also illustrates another fact, and that is that the Normal School of Science is not the outcome of some cut and dry report of a commission, founded possibly on a foreign example, but it is the natural outgrowth of what has been found to be required. It has grown so as to suit its environment, and so far is a thoroughly English institution; and now that it has in the fulness of time—I will not say that the time may not have been a little too full—now that it has come out in its full plumage, I think the country may be congratulated on this. It has a scientific educational institution fairly provided with apparatus and appliances; but it has what is far more valuable. It has a staff of professors whose position in the scientific world for the work they have done, whose power of teaching and imparting knowledge, and whose zeal in the cause will, I believe, bear comparison with the staff of any other similar institution, or seat of learning in this or any other country at the present time.

The Chairman:—I have now the pleasure of calling on Prof. Huxley, the Dean of our re-organised institution.

Prof. Huxley:—Mr. Mundella, under ordinary circumstances the address the Dean of the School is called upon to make on occasions of this kind is confined to a statement of the condition of the school, and to an account of the manner in which the various departments of instruction are thriving or otherwise. But as this institution, the Normal School of Science and Royal School of Mines, is extremely young—in fact has not yet completed the first year of its existence—I think, with your permission, it may be well that I should call the attention of those who have honoured us by their presence to facts with which your official mind is perfectly familiar, but of which they cannot be expected to have cognisance.

As Col. Donnelly has just remarked, this institution has not been so much made as it has grown; it is therefore a particularly English institution, inasmuch as in that respect it resembles the British constitution, which, from an abstract and logical point of view is probably not the most symmetrical and reasonable fabric that ever was raised, but which has the great merit of having grown out of the actual conditions of life, and of possessing the power of adapting itself to the incessant changes of our social state. The school is not, as might be judged from its title, a dual institution like the Austro-Hungarian monarchy; but it has grown out of the growth, development, and eventual coalescence of two perfectly distinct and independent organisations, which have at different times, and quite independently of one another been set on foot by the Government of this country for the purpose of giving science—by which I mean physical science—that influence upon the industries and arts of the country which, as every one now recognises, is absolutely essential to their sound and rapid progress. The Royal School of Mines was practically established, or rather the foundations of it were laid, so far back as the year 1851, at which time a very staunch and kind friend of mine, at a time when friends were not quite so plentiful as they are now, the late Sir Henry De la Beche, one of the most sagacious and able men it was ever my good fortune to meet with, having set agoing, chiefly by his own energy, the Geological Survey of Great Britain, obtained the attachment to that service, and to the Museum of Practical Geology, which was connected with it, of an institution which I think may be described as the first technical school which was ever established in this country by the influence of Government; I do not know if private enterprise had done anything of the kind before. This institution was termed "the Government School of Mines, and of Science applied to the Arts"; and you will observe, and I call your attention to the fact, that in that title there is a duality of precisely the same nature as that which exists in our present name. No doubt one of the objects most dear to Sir Henry de la Beche and his associates, was the establishment of a technical school for those branches of science of which the applications are more or less direct to mining and metallurgy; and no doubt a considerable proportion of the influence which was brought to bear in establishing the school arose from the fact that the mining and metallurgical industries of the country were largely interested in it. But you will also observe that the school took upon itself the teaching of "science applied to the arts," and we had therein a germ, for it was no more than a germ, of what may be termed a general technical school.

Now it was about the same time that the Great Exhibition of 1851 directed the attention of people in this country, far more strongly than it had been directed before, to the extreme importance of giving our industries some better foundation than the mere rule of thumb, which up to that time had too largely obtained. That movement grew and became more important until it resulted in the creation of the Science and Art Department, the effects of which upon the art side, are unmistakeable, for you have them in this vast museum in which you now meet, which I believe is without its parallel in the civilised world. That side of the activity of the Science and Art Department grew rapidly; but the other side of it, the development of the technical application of science, was indeed attempted, but got very little further than the attempt. That attempt was made in this wise: the course of instruction in the Government School of Mines and Science applied to the Arts, then lodged in Jermyn Street, was enlarged so as to include an addition to its mining and metallurgical division, which was called a general division—a general training in physical science—and a technical division, that is to say, what we now understand as a technical school. Moreover, the Royal College of Chemistry was combined with the School of Mines; and in order, as it were, to emphasise the development of the general technical school side of the institution, its title was altered into that of the "Metropolitan School of Science applied to Mining and the Arts." That was in the year 1853, very nearly thirty years ago—a generation of men; and I have no hesitation in saying that if the idea which at that time obtained in the minds of the heads of the Department of Science and Art had been developed and carried out, it would not have been left for this generation to make the efforts which it now seems prepared to make in various ways for the establishment of a thorough and effectual system of technical education throughout the country. Whether it was that the time was not ripe for such an effort, or from what other cause, it is not worth while to inquire; but this course of development was more or less nipped in the bud. The instruction in Jermyn Street narrowed instead of widening; the general and technical divisions were gradually abolished, and the institution restricted itself as far as it could, to being a school of mining and metallurgy, pure and simple; with this difference, however, that the very large and efficient organisation for teaching chemistry under Prof. Hofmann, which existed at that time, retained a certain amount of *quasi* autonomy, and did specially profess to teach the applications of chemistry to industry. The change of policy was signalised in the year 1859 by another change of name; the institution was then called the "Government School of Mines," and so it remained for a few years, until in 1863 the title was altered once more, by way of giving the institution extra dignity, to the "Royal School of Mines," which title it has retained ever since.

I had the honour to be appointed one of the professors of the School of Mines in the year 1854. I have now, therefore, completed twenty-eight years' connection with it. I estimate that connection as one of the happiest and most honourable events of my life, having always been associated with colleagues with whom any man might have been proud to act. Moreover, let me say, in respect of such change of policy as has taken place, I am just as much responsible as anybody else, so that you must not think that I have the smallest intention of saying a word which could militate against the estimation which the School of Mines, I am happy to say, always has held, and which I profoundly trust it always will hold, if I point out to you that there were, from the very beginning, certain extremely grave defects in its constitution. I cannot say that they arose from the fault of any body concerned, but from the fact that the necessities of scientific training were understood a quarter of a century ago in a totally different way to that in which they are now understood. The only provision which was made for that practical instruction, which is the heart and soul of all efficient scientific education, in the original School of Mines, consisted in the laboratories for chemistry and for metallurgy. For no other branch of science was there any efficient practical teaching provided, and even the accommodation for chemistry and metallurgy was so imperfect, that within a very few years after the foundation of the school, laboratories for these purposes had to be sought elsewhere. For eighteen years I did my duty as well as I could towards that institution, lecturing about natural history, and I am sorry to say, all the time, with the more or less definite consciousness, that I was an involuntary impostor, and that it was not possible for me to teach in any genuine fashion, because I had no room in which practical instruction could be given. I do not know whether my colleagues would be inclined to make the same confession, but the same want must have been felt in the teaching of physics, and in the other kinds of instruction given in the school. Moreover, we had no mathematical instruction, and, in spite of our repeated representations, it was not provided.

Now that state of things obtained up to the year 1872. By that time some of us had got extremely tired of it, and I was one of those who were so tired, my chemical colleague was another, my colleague the Professor of Physics was a third, and we got up a sort of little pronunciamento to say that we really could not go on teaching in that way any longer; that at South Kensington there was a large building which was standing perfectly empty, and might we be allowed to do our business in a more efficient way by being transferred to this empty building? With the assent and consent of our colleagues, and with the sanction of the Department of Science and Art, the desired transference took place, and the result of that was, that all the professors who were moved were able at once to institute a more or less adequate system of practical instruction, and to make the teaching in the school in their own departments something like what it ought to be. Subsequently the Professors of Geology and Metallurgy and Applied Mechanics were similarly moved, until now only the Professor of Mining remains in Jermyn Street, simply because he has there the admirable collection of models which are so important for his work.

That, Sir, is the history so far as it can be told, in a few words, of the origin and growth of the Royal School of Mines. The only change that has taken place in consequence of the new organisation in that institution is that it has been made more efficient. Mathematical instruction has been added; practical teaching has been supplied in all branches of science which the Associates of the Royal School of Mines are required to study, and I cannot doubt, seeing the respect which has for many years been paid to the title of Associate of the Royal School of Mines, that that respect will simply grow and increase with the knowledge of the public, that the only alteration which has taken place here of late years is to make the title represent a very much larger value than hitherto it has been possible it should represent.

Now, sir, I turn to the Normal School of Mines, about which my task will be easier, because Col. Donnelly has said something about it. I have spoken of my respect and affection for the older institution, the Royal School of Mines, with which I have been so long connected, but I am not quite sure that, looking at the matter from a broad and general point of view with reference to the influence of our school upon the country, that I may not have taken an even greater interest in the series of steps which have led to the organisation of the Normal School of Science. It is very hard for those whom I address, and who have not the advantage or disadvantage of being as old as I am, to believe that there was a time, hardly more than a score of years ago, when it was almost impossible for any one who was not connected either with the universities, with the medical schools, with the School of Mines, or with one or two institutions in London, to obtain the slightest tincture of practical scientific instruction in this country. When, therefore, those conferences and deliberations, to which Col. Donnelly referred just now, came to my knowledge in the year 1859, I felt profoundly interested, and I thought the plan proposed extremely well devised, and that it was the only one, whatever its imperfections may be, which at that time was adapted to meet the wants of the time. I confess that when I heard of the establishment of these science classes, I made the same sort of reflection as the man who said let him make the songs, and he did not mind who made the laws. I said to myself, I do not care in the slightest degree from this time forth what the universities, or what the public schools may do in the way [of teaching science to the non-professional classes; they are bound now *se soumettre ou se demettre*; either they will follow in the wake of this movement towards general scientific education of the country, or they will pass out of the stream of progress of modern culture. You may think that was a very large anticipation to base upon a small foundation, and undoubtedly it was; but the immense development of this system of scientific teaching has, I think, entirely verified my anticipation, and I am happy to say that the public schools and the Universities have followed suit, until now it is as easy to obtain a fair general scientific training in this country, as a quarter of a century ago it was difficult.

Well then, this system of science classes having spread over the country, it soon became apparent that the greatest obstacle to its efficiency lay in the want of knowledge of proper modes of teaching on the part of teachers. It is lamentable how much the ordinary mode of education in what is often called literature, but commonly is not, tends not only not to help a man to become a learner or a teacher of physical science, but rather to impede his becoming one. Nothing is more surprising to me than to find a number of instructed persons coming up here for scientific education, and to discover that they cannot observe. They have been so accustomed to take statements on credit from books and word of mouth that they have almost lost the faculty of seeing things for themselves. I remember after having given a lecture, accompanied in my ordinary way by drawings on the blackboard, that I went to look through the microscope, and see what one of the students who had heard this lecture was drawing. To my astonishment, I saw that his drawing was the thing I had drawn on the blackboard, not the thing under the microscope. I said to him, What is this? this is not at all like what is under the microscope. No, he said, that is what was on the blackboard. He did not believe nature, he believed me; and the great lesson I have tried to teach, which is the fundamental basis of scientific teaching is, do not put too much faith in your teacher, but do believe nature. The only way of remedying this evil habit of taking science on trust, is to give the science teachers the opportunity of obtaining a discipline in the methods and a practical acquaintance with the most important facts of the particular branches of science which they profess to teach. That has been done partly by bringing up teachers from the country for short courses such as are now going on, or will shortly be going on in this institution, and partly by giving them the opportunity individually of attending the courses of the Royal School of Mines during its separate existence. What happened last year was that this system of bringing up teachers for scientific training, for training, that is to say, in special branches of science, was made systematic and thorough. By adding to the staff of the Royal School of Mines a chair of Mathematics and Mechanics, a lectureship on Astronomy, a lectureship on Agriculture, in addition to lectureships on some other subjects, and by providing full means of practical instruction, the institution is now able to provide for a tolerably efficient training, extending over a considerable number of months, of teachers of the science classes in those matters of elementary science which it is needful for them to understand thoroughly in order to teach properly.

Having been practically interested in the administration of the great measure of education for the masses of the people, which was set on foot a dozen years ago, it is particularly gratifying to me to see this last step taken, because it appears to me that so far as science is concerned, it is the crowning of all the organisations which a Government may and should undertake in regard to the education of the masses of the population. The result is this: At this present time, if there be anybody in the remotest district of England in which these science classes are established, if there be any child who has a faculty for science, which is a thing inborn, and as much a genius as the faculty for art; that child, boy or girl, as the case may be, has open to him or her the means of instruction in one of the science classes. To those who have not any special faculty, science certainly will not do any more harm than learning anything else that they learn without understanding, as most boys do learn so many things at all schools. But if the scholar possesses this scientific faculty which I just now spoke of, it is open to him to distinguish himself at the May examinations. If he distinguishes himself at the May examinations, scholarships are open to him at various institutions, among the rest in this Normal School. If under the instruction which is offered to him, he shows a higher kind of scientific capacity, I do not know that there is any limit to the point which he may eventually reach. If he has in him the making of a Davy or a Faraday—and once in thirty or forty years men of that kind are born in the most out of the way and unlikely places—if he have that faculty, there is no longer a need that he should hopelessly struggle with adverse obstacles, but the path to reach that position in which he may serve his country most effectually is laid open to him by the organisation which I have described. And in order to make that organisation complete, we are endeavouring to give such instruction to the teachers as will enable them to aid in this business of picking out from the mass of youth under instruction those who are most likely to attain scientific distinction, and to train and inform those who are likely to profit by scientific instruction.

I am sorry, Sir, that I have detained you so long. It now only remains for me to report to you that, at present, the number of students in the Institution amounts to 198. I may say, that in only one or two classes is there a slight falling off in numbers. In several the numbers are enlarged, particularly in the metallurgical class, and in the geological class, in which latter the demand for a system of instruction which has been established here by my colleague, Prof. Judd, has been so considerable, that several have had to be turned away for want of accommodation. You will be glad to know that this system is so thorough and so efficient, that from abroad men are sent to study its working. The whole school is at present in a very healthy condition. Some little difficulties attended its birth, as is very often the case with strong and lusty infants; but I think our infantile complaints have all now subsided, and I hope that the institution may look forward to a vigorous manhood.

General Martin was then called upon to read the names of the successful students. He said: The ceremony to-day of necessity came so closely on to the heels of the examinations, that the general lists could not possibly be made up. Only those awards, therefore, would appear to-day which could be ascertained in time. For this same reason we may hope that some other gentlemen, in addition to those who receive the Associateship to-day, will be found to be qualified, and receive it hereafter.

The following names were then read, and the certificates and prizes were delivered by the Chairman:—

List of Students who are to receive Associateships, June, 1882

A. W. Day	1st Class	Mining
F. W. Harbord	1st Class	Metallurgy
G. Kamensky	1st Class	,,
F. L. Cepero	2nd Class	Mining
G. Ross Divett	1st Class	,,
J. E. Green	2nd Class	Metallurgy
J. P. Walton	1st Class	,,
F. L. I'Anson	2nd Class	Mining
M. Staniland	1st Class	Metallurgy
	2nd Class	Mining
F. T. Barnett	1st Class	Metallurgy
J. H. White	1st Class	,,

Award of Prizes, Scholarships, &c., June, 1882

2nd Year's Scholarships	H. F. Collins R. T. Bodey
1st Year's Scholarships	A. Sutton H. W. Hughes T. Mather H. G. Graves

Medals, &c.

"Forbes"	C. J. Gahan
"Murchison"	H. F. Collins
"Tyndall"	W. T. Burgess
"De la Beche"	C. H. Powell
"Bessemer"	J. J. Hood (1880–81) F. W. Harbord
Chemistry Prize, "Hodgkinson"	C. A. White

The Chairman:—Mr. Dean, ladies and gentlemen, in the discharge of the duties of my office I have seldom had to perform a more interesting duty than the one I have just fulfilled, of distributing the awards to the successful students on this occasion. I am not going to detain you at this hour with a speech, especially as you have had a most excellent address from that master of science and oratory, the Dean of our Normal School. It would not only be bad taste, but it would be a great indiscretion on my part, if surrounded by men so eminent in science, I ventured to talk to this audience on any scientific question. All I have to express is my great gratification in being in the humblest degree instrumental in bringing the Normal School to its last phase, and to its present position. I am sorry that my noble friend, the Lord President of the Council, who is at this moment discharging also the arduous duties of Lord Lieutenant of Ireland, is not here to day to preside over this interesting ceremony, for he took the greatest possible interest in the reorganisation of the school, and of bringing it into the position which fulfils so admirably the conditions of usefulness which Prof. Huxley has so well described to you.

We have all felt in the words which fell from Col. Donnelly how much science and art in this country and in this place owe to the late Sir Henry Cole, and I should not feel satisfied to address this audience without expressing my own deep conviction of the great service which he rendered to his country, services which will endure for generations and centuries, the value of which we only yet very imperfectly realise. Prof. Huxley pointed out how slow the growth of science teaching in this country had been as compared with the success of art-teaching. It is hardly to be wondered at how much more easy it is to appreciate beauty and art as applied to industry than to see at once the advantages which science confers on industry. Even the most superficial of us who have lived for the last thirty years cannot walk through the streets of London, cannot look into any ordinary shop, or look into a shop window, without being struck with the marvellous change which has come over the textile and metallic productions of this country in the way of their artistic character. There is nothing so remarkable as the change which has taken place in our curtains, or carpets, or hangings, or furniture, or decorations, in everything admitting of the application of art to our common life. There is nothing more charming or more agreeable to realise, but it is not so easy to understand the enormous value and importance of scientific instruction, as it is to appreciate at once the advantages of art training. The influence which art has had on the industry of this country through the instrumentality, I think, in the first instance, of the late Prince Consort, and the men who surrounded him thirty years ago at the exhibition of 1851—that influence is something incalculable, I believe, not only in its advantages to those of us who enjoy the pleasure of these more interesting surroundings, but also in the industry of the country, and in the extent of its employment and manufacture, and the hundreds and thousands of people who are benefited by an increase of our export trade. But we have, and I am glad to know that the manufacturers of this country are beginning to realise it, been far behind in science-teaching. We have been behind our neighbours in France and Germany, and other countries. They have within the last twenty or thirty years made prodigious efforts, and are still making prodigious efforts to apply science to individual industry, and to avail themselves of the resources of science in order to improve their manufactures and to develop the resources of their country in order that they may successfully compete with us in the markets of the world. I know nothing so astonishing as the lavish expenditure and the prodigious efforts that France and Germany have made within the last ten years to increase science teaching in those countries. However, if we have been slow in our growth, I am not at all disheartened, because I believe it has been sure, and, as Prof. Huxley has told you, it is better fitted to the circumstances and wants of our country, probably, than the Government-created institutions which have prevailed abroad. I do not want for one moment to anticipate the report of the Royal Commission on technical education which is now pursuing its investigations. I am quite sure that Commission will lay before Parliament and the country not only a most interesting, but a most startling report; but at the same time I am not at all afraid that we are so behind that we cannot adapt ourselves to the circumstances of the case, and that we shall not continue to hold our own in the industrial progress of the future as we have in the past.

Prof. Huxley told you that, twenty-five years ago, in our provincial towns, and even in London, there was hardly any opportunity for scientific instruction. I know in my own early days the only opportunity an inquiring young man had was to be found in the classes of Mechanics' Institutions, where some amateur student of science was willing to convey to his fellows some share of the little knowledge which he himself possessed. But anything like systematic scientific instruction was utterly unknown in the great centre of industries of this kingdom thirty years ago. To-day, in connection with the Science and Art Department, there are 1760 teachers, at least, principal teachers, I am excluding assistants. There are 60,000 students in schools receiving grants from the Government, in connection with the Science and Art Department. There are about 200 students that we have here in this institution, 50 of whom are in training as teachers, and there are 200 science teachers who come from the provinces ever year to receive short courses of instruction, with their travelling expenses paid, and an allowance made to them whilst they are pursuing their studies in this institution. We have also twelve exhibitions of 50*l.*, four of 15*l.*, and two of 25*l.*, which are awarded annually by the Government. These are only the nucleus, so to speak, of numbers of exhibitions which are given in various localities, and that bring to this institution for training, the men who have the faculty for science teaching, and who will be the future teachers for science in this country. I am sure no one can have been present to-day, and have seen those young men advance to the table, and have seen them receive their certificates of associateship, and their honourable awards for their successful studies, without feeling that those men are going to carry to all the centres of industry an amount of light and knowledge which will be of immense advantage, not only to themselves, but to the industry with which they are associated. In every part of England there is a demand for technical instruction, and that demand is very much groping in the dark, for our people hardly understand what they mean by it yet. It means they want to know the *rationale* of the work which they are doing. They are tired of working by rule of thumb, that when, as I have heard a Dyer explain how he got certain results, he tried his alkalies and acids by dipping his thumb into them and tasting them, and when he found the components for some particular dye, he took a shovelful of this and a shovelful of the other, and so arrived at certain results which he could rarely arrive at with precision again, but which was mere guesswork, rule of thumb, chance, and accident; all that is passing away, and I believe, as the result of the good work that is doing in this institution. I am sure you will all join with me in expressing the hope that our Dean, who holds that title for the first time during the last year, will long remain at the head of this institution, to carry it to that success to which he aspires, and which he has done his utmost, by his noble effort and by his constant and eloquent advocacy, to secure.

DUNSINK OBSERVATORY[1]

MR. DREYER, having been appointed to succeed the late Dr. T. Romney Robinson as director of the Armagh Observatory, will vacate his post here next September. An advertisement has been inserted in NATURE inviting applications for the post of assistant. I have received a number of replies, but I am not yet in a position to make a definite recommendation. I do not like to allow Mr. Dreyer's resignation to pass without expressing the high opinion I have of the manner in which his duties here were discharged.

The meridian circle has been as before in the entire charge of Mr. Dreyer. During the past year Part IV. of the Dunsink Observations and Researches has been issued, in which is contained an account of the meridian circle and a catalogue of the red stars whose places have been determined. In July and August many nights were spent observing the two bright comets, but the weather was so unsettled that only four observations of Comet III. and two of Comet IV. could be secured on the meridian.

In September a series of observations of stars between − 2° and − 23° declination were commenced. In all there have been made 713 observations of transits, and 582 observations of declination; the reductions to apparent place are completed for R.A. up to December 11, and for decl. up to March 10.

The meantime clock service has been continued throughout the year. The circuit has been tested on 349 days—from July 1 up to June 14—with the following results:—

265 days'	error not greater than 1 sec.
56 ,,	between 1 sec. and 2 secs.
28 ,,	greater than 2 secs.

I referred in my last report to the chronograph which Mr. Grubb has had in hand. From a great press of other work, the instrument has not yet been quite finished, but I think we may now regard the chief difficulties as conquered, and I look forward very shortly to having a chronograph which will enable us to do real justice to the meridian circle.

The South Equatorial has, as before, been chiefly employed by myself in the observations of stars for annual parallax. The number of the observations made altogether amount to 186. This number is less than that in former years, because several series of observations have been brought to a close during the present year, and the results have been discussed and prepared for publication. I now submit the manuscript which is ready for the press as Part V. of our publications. The work will be considerably larger than the parts formerly issued, and will contain 200 pages or somewhat more. It consists entirely of the parallax researches made by myself at the South Equatorial in the last four years, and brief abstracts have occasionally appeared elsewhere. I now only glance at the portions completed since the last visitation.

In my last report I stated that the measures of the position angle of + 50°, 1724, from Groombridge, 1618, required further discussion: that discussion they have since received, and the result is very satisfactory. From the distances I had obtained from Gr. 1618 a parallax of

0″·334 ± ·036.

From the position angles the discussion now submitted gives a parallax of

0″·314 ± ·031.

By combining these results, we find as the result of 106 nights of observation the mean value

0″·322 ± ·0″·028.

Considering the smallness of the probable error, it can hardly be doubted that this object has a parallax of a third of a second.

I also submit the completely discussed observations of 368 stars which have been examined in the manner already described as reconnoitring for annual parallax. In the great majority of cases the results are negative, yet even in these cases I believe the work is of value as a part of the general survey of the heavens. It is also, I believe, the only systematic effort which has yet been made to search for the nearest neighbours of the sun.

I am, however, glad to say that all the results of this work are not purely negative, but that certainly in one instance, and probably in others, results of considerable interest have arisen. At the present moment I am only in a position to speak definitely as to one object, viz. this star 6 Cygni B = Σ2486.

My attention was directed to the star from the circumstance that the reconnoitring observations indicated a probable parallax, and I determined to observe it systematically. The observations were made on 33 nights, the first being November 30, 1879, and the last being December 22, 1881, observations of the distance and of the position angle now submitted. The mean value of the parallax from the distances is—

+ 0″·504 ± ·060,

and from the positions

+ 0″·383 ± ·130,

the mean being

+ 0″·482 ± 0″·054.

It is a matter of considerable interest to observe that this is about the same parallax as that of 61 Cygni, another object in the same constellation, and a double of the same character.

The proposed part v. will consist of five papers, as follows:—(1) Reconnoitring observations of 368 stars, with a view of finding whether they have a large parallax; (2) on the annual parallax of Groombridge 1618; (3) further researches on the annual parallax of 61 Cygni; (4) on the annual parallax of P. III., 242; (5) on the annual parallax of 6 Cygni B.

Brief accounts of the results of 2, 3, 4 have already appeared in the *Proceedings* of the Royal Irish Academy or in the special astronomical journals. It is now proposed that they shall be issued fully and with all the information necessary to enable astronomers to judge them adequately.

Besides this work, which I now submit as completed, there is a large mass of other work which is in a partially completed state. The red star Sch 249 (*a*) seems to have a parallax, and I have completed two sets of observations thereon. These have indeed been finished for some time, but I have not yet been able to complete the discussion, and further observations will probably be necessary. I have also completed two sets which will give four independent determinations of the parallax of μ Cephei. There are also some hundreds of the reconnoitring observations in a half-completed condition, most of which I hope to observe during the autumn.

Up to the present I have almost entirely confined my work with the South Equatorial to the researches on annual parallax with which Dunsink is historically associated. I have, however, after some hesitation, decided to co-operate in the proposal of Mr. Gill, her Majesty's Astronomer at the Cape, to determine

---

[1] Report on the Work of the Dunsink Observatory between July 6, 1881, and June 26, 1882, made to the Board of Trinity College, Dublin, at the Annual Visitation on June 27, 1882. By Prof. Robert S. Ball, LL.D., F.R.S., Royal Astronomer of Ireland.

the sun's parallax by observation of Victoria and Sappho. I have already commenced the preliminary work, and I anticipate that much time will be devoted thereto in the ensuing autumn.

ROBERT S. BALL

SCIENCE IN BOHEMIA

A CORRESPONDENT, who was present at the recent meeting of the Bohemian Naturalists, sends us the following brief report:—

The second meeting of Bohemian Naturalists and Physicians was held during May 24–30 in Prague (NATURE, vol. xxvi. p. 66). This meeting, in which over 600 members (some of them coming from Poland) took part, seems to have proved sufficiently that the above-named Slavic tribe (counting only something over six millions of souls) is not less successful in cultivating and promoting science in its own language, than other small nations (Dutch, Swedes, &c.).

In the two general meetings the following addresses were given:—By Dr. Schafarik, Professor in the Bohemian University, on the aims of chemical investigation, in which the subject was treated from an unusually deep and philosophic point of view; and by Dr. Holub, on the importance of the medical profession in transatlantic countries. In this address the essayist pointed out that the great power which had been obtained by the English in transatlantic countries is especially due to the investigations made by them from the scientific, commercial, economical, and strategical point of view. Dr. Holub further referred to other experiences of that kind, which he made in his travels in South Africa, already known to the readers of NATURE (vol. xxiv. pp. 35–38).

In the Section for Medicine, papers were read by the following gentlemen:—Doctors Eiselt, Janovsky, Maixner, Drozda, Thomayer, Chodounsky, Hlava, Wiktor, Zahor, Pelc, Böhm, Belohradsky, Ehrmann, Carda, Krasinski, Chudoba, Mayzel, Steffal, Wach.

In the Section for Surgery, papers were read by Doctors Schoebel, Obtulowicz, Janovsky, Janda, Kuniewicz, Michl, Medal, Talko, Weiss, Bastyr, Jerzykowski, Ostrcil, Carda, Michl, Matlakowski, Spott, Maixner, Skalicka.

In the Section for Pharmacy, papers were read by Doctors Belohoubek, Jandous, Fragner, and Stepanek.

In the Section for Mathematics and Physics, Dr. E. Weyr read a paper on the construction of a hyperboloid of osculation; J. Vanecek, on general inversion; V. Jaeger, on the solution of equations of 4th degree; K. V. Zenger, on a dispersive parallelopipedon, and on microscopes with endomersic lenses; Dr. Doubrava, on sensitive flames; Dr. Becka, on comets; F. Machovec, on the construction of certain curves; Dr. Weyr, on the construction of rational curves in space, of third, fourth, fifth, and sixth degrees; B. Prochazka, generalisation of stereographic sections of planes of second degree; A. Sucharda, on movements of curved planes; F. Toms, construction of section lines of two conic sections; F. Cecbac, contributions to electrotechnics; Dr. A. Seydler, on the use of quaternions for the solution of a certain mechanical problem; Dr. V. Strouhal, on the peculiarities of magnetic and galvanic steel; E. Dziewulski, electric conductivity of mixtures of alcohol and water.

In the Section for Natural Science, papers were read by Dr. Celakovsky, on the sympodial constitution of vine-branches; J. Szyszylowicz, on the influence of light upon the transformation of matter in plants; F. Bayer, on the asymmetry in the shoulder-blade circle of frogs and some birds; V. T. Velenovsky, on the flora of Bohemian chalk-formation; Dr. Palacky, on the relations of the American and Bohemian flora; F. Sitensky, on the turfs from the giant mountains; K. Cermak, on the stratification of the alluvium and diluvium in certain parts of Bohemia, the fauna of these strata, and their deposition over older formations; Dr. Mayzl, on the division of cells; Dr. Fric, on the Sauria found in the permic formation of Bohemia; F. Safranek, on a new rock found near Tabor (Bohemia); J. Korensky, on the diluvial fauna from the rock-cave near Tetin; J. Kafka, on Bohemian bryozoa; Dr. Woldrich, on the diluvial system of Central Europe; G. Ossowski, geology of Wolonia; Dr. Novak, contributions to the fauna of Bohemian Siluric formation; J. Fric, contribution to the ontogeny of Copepoda; Dr. Kamienski, contribution to the morphology of the urticularii; J. Ssyszylowicz, conservation of spores of plants during the winter; K. Taranek, on rhizopoda and diatomacæa of South Bohemian turfs; S. [Klnava, criteria of modern petrology; Dr. Celakovsky, comparison of indusia of ferns and oval integumenta; F. Safranek, on a new find of opals and chalcedons near Tabor; Dr. Vejdovsky, on the male of *Lernæpoda selachiorum*, and on Bohemian Planariæ; Dr. Hansgirg, on Bohemian Algæ, and on the movements of Oscillariæ; J. Ulicny, on Moravian Molusca; Dr. Zulinski, on mineralogical symbolics; Dr. Palacky, on the flora in the Bohemian chalk formation; C. Zahalka, geological map of the environments of Jicin; Dr. Kamienski, growth of plants in an atmosphere not containing carbon dioxide; F. Posepny, on the disintegration of rocks; Dr. Rostafinski, on the distribution of Galician fishes, and on the formation of hormogonia.

In the Chemical Section papers were read by Prof. Butleroff, on the oxidation of isodibutylene by potassium permanganate (presented); Dr. Radziszewski, on physiological oxidation; F. Stolba, application of aluminium-metal in laboratories; A. Belohoubek, on crystallised hydrates of potassium; Dr. B. Brauner (Manchester), on the atomic weight of didymium and other researches, regarding the chemistry of rare earth-metals (presented); F. Chodounsky, on fermentation; Prof. Preis, on sodium sulfarsenite; Dr. Janecek, on the electrolysis of saline solutions; Dr. Wasowicz, on crotaconic acid; Farsky, on superphosphates; K. Kruis, fermentation in spirit-refineries; M. Fischer, on the decomposition of collagenous substances; J. Stoklasa, on the geochemical conditions of Bohemian chalk-formation; Jal, on the estimation of hypophosphorous acid; J. Wiesner, on potassium-uranic chromates; K. Sykora, on certain coloured clays found in Bohemia, B. Rayman, on a new synthesis of methyl-phenyles; Farsky, chlorine as a nutriment of plants.

In the Section for Archæology and Anthropology, papers were read by Dr. Woldrich, on the skulls of prehistoric domestic dogs; J. Ossowski, on the objects found in caves near Cracow; Dr. Berger, on fibulæ found in Bohemia; Dr. Kopernicki, on the trepanation of prehistoric skulls in Bohemia; B. Jelinek, on the environments of Plesivec.

In the Section for Pædagogy the following papers were read or subjects discussed:—Dr. Hejzlar, how to teach physics and astronomy; F. Nekut, how to teach mineralogy; J. Mrazik, on the services rendered to pædagogy by medicine and natural science; J. Vanecek, necessity of teaching new geometry in middle schools; Dr. Kotal, on the treatises of natural science used in middle schools; J. Klika, how to popularise natural science; Pokorny, on teaching of gymnastics.

In an exhibition connected with the meeting many interesting objects touching upon [Medicine and Natural Science were exhibited. From the scientific excursions by which the meeting was concluded only that into the well-known mine of Pribram, under the direction of Prof. Krejci, may be mentioned.

Only within recent years Natural Science began to be cultivated in Bohemia in the Slav language, and this is especially due to the establishment of a Bohemian Polytechnic School and recently of a corresponding division in the University of Prague though the last-named high school was founded already in 1348.

INDIA-RUBBER PLANTS

MR. W. T. THISELTON DYER brought before the Linnean Society, June 15, an important communication on the caoutchouc-yielding Apocynaceæ of Malaya and Tropical Africa. After giving a general sketch of the structural and physiological conditions of the occurrence of caoutchouc in plants, the author pointed out that the plants which appeared to yield it in commercial quantity in three widely-separated regions all belonged to one tribe of Apocynaceæ, the *Carisseæ*. In the East Indies the "gutta singgarip" of the Malay Peninsula, the "gutta soosoo" of Borneo, was the produce of a new species *Willughbeia*, *W. Burbidgei*. Many other species of this and allied genera also seemed to produce caoutchouc in quantity, worth collection. In Central Africa *Landolphia*, which was closely allied to *Willughbeia*, but differed in possessing terminal instead of axillary flowers, was the most important source. On the East Coast caoutchouc was yielded by *L. owariensis* and *L. florida*, the latter a very ornamental plant. As the rubber exuded from the cut stems, it was plastered by the collectors on the breast and arms, and the thick layer, when peeled off and cut up into squares, was called "thimble rubber." On the west coast the most important species was *L. Kirkii*, the rubber of which could be wound off into balls or small rolls from the cut stems, like silk from a cocoon; this species was called "Matere." *L. florida* also occurred, and was called "m'bunga"; its rubber was worked up into balls, but was inferior in value. The rubber of *L. Petersiana* was of little importance. In South America *Hancornia speciosa* yielded what was called "mangabeira rubber."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

At the summer commencements of the University of Dublin, held on June 29 last, the degree of LL.D. Honoris causâ was conferred on Dr. Siemens and on Mr. Alfred Russel Wallace.

At a special meeting of the Council of the University of Dublin, held on June 30, Mr. Robert Crauford was nominated for the important post of Professor of Engineering in the University. Mr. Craufurd is well known for his many fine engineering works successfully carried out in North and South America, and in Europe.

UNIVERSITY COLLEGE, BRISTOL.—The new wing of the permanent buildings of University College, Bristol, is now rising rapidly. The portion devoted to physical and engineering laboratories and lecture-rooms will be ready for occupancy in October; the new chemical laboratories and lecture-rooms will be completed before Christmas. This greatly-needed extension will not, however, meet all the requirements of the growing institution, and additional buildings to accommodate the medical faculty are greatly wanted. One of the laboratories of the Physical Department is to be fitted up as an electrical laboratory. Prof. Thompson is actively endeavouring to raise funds for its complete outfit. Mr. C. C. Starling has been appointed Demonstrator in Physics.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 15.—"On the Specific Heat, and Heat of Transformation, of the Iodide of Silver, AgI, and of the Alloys $Cu_2I_2.AgI$; $Cu_2I_2.2AgI$; $Cu_2I_2.3AgI$; $Cu_2I_2.4AgI$; $Cu_2I_2.12AgI$; $PbI_2.AgI$." By Sigr. Manfredo Bellati and Dr. R. Romauese, Professors in the University of Padua.

The authors have determined the specific heat, and heat of transformation, of iodide of silver, and of five alloys or compounds of that substance with iodide of copper, and one with iodide of lead. The substances have already been studied by Mr. G. F. Rodwell as regards their expansion and contraction on heating, and the results communicated to the Royal Society; the same specimens were transmitted to Padua for the experiments of Prof. Bellati and Romanese. The following results were obtained. θ_1 and θ_2 are the temperatures at which change of molecular structure respectively commences and finishes; c the mean specific heat between t and T for temperatures below θ_1; c_1 specific heat for temperatures above θ_2; and λ the heat absorbed by the unit weight of the substance in consequence of change of structure.

Composition of the substance.	Percentage of AgI.	θ_1.	θ_2.	c.	c_1.	λ
		C.	C.			
AgI	100·0	142°	156°·5	0·054389+0·0000372(T+t)	0·0577	6·25
$Cu_2I_2.12AgI$	88·1	95	228	0·05882 (from 16° to 89°)...	0·0580	8·31
$Cu_2I_2.4AgI$	71·2	180	282	0·056526+0·0000410(T+t)	0·0702	7·95
$Cu_2I_2.3AgI$	65·0	194	280	0·059624+0·0000280(T+t)	0·0726	7·74
$Cu_2I_2.2AgI$	55·3	221	298	0·061035+0·0000295(T+t)	...	7·88
$Cu_2I_2.AgI$ ...	38·2	256	324	0·063099+0·0000260 T+t)	...	8·67
$PbI_2.AgI$ ...	33·8	118	144	0·047458+0·0000026(T+t)	0·0567	2·556

The results are compared and discussed, and inferences are drawn therefrom as to the constitution of the bodies experimented upon.

Geological Society, June 7.—J. W. Hulke, F.R.S., president, in the chair.—Alfred Morris, C.E., and William Henry Watson were elected Fellows of the Society. Prof. Louis Lartet of Toulouse was proposed as a Foreign Correspondent of the Society. The following communications were read:—The President read the following note, forwarded by Don Manuel F. de Castro, Director of the Geological Survey of Spain:—"On the Discovery of Triassic fossils in the Sierra de Gador, Province of Almeria, Spain. The metalliferous limestone of the Sierra de Gador, owing to no fossil remains having been found prior to this occasion, has been a perfect puzzle to all geologists for the last fifty years. MM. Maestre, Amar de la Torre, Pernolet, Ansted, and Cooke considered these limestones to belong to the Transition series, the former taking it as a representative of the Mountain Limestones of other parts of Europe. M. Prado hinted that they might be Devonian; whilst M. Willkomm, in the geological map published to accompany his botanical researches in Spain, considered them Silurian. Lately MM. Botella and Vilanova, in their respective maps, have marked them as belonging to the Permian series, whilst M. de Verneuil, coming nearer to the truth, took the whole of the limestones to the south of Granada and the Sierra de Gador as Triassic, though in doubt ('Trias incertain') Under these circumstances I was commissioned by the Director of the Geological Survey of Spain to investigate the south-west portion of the Province of Almeria, which comprises the Sierra de Gador. In February last I had the good fortune of discovering abundant fossil remains in different parts of the Sierra de Gador, which perfectly fix the age of the metalliferous limestones of this part of Spain. The whole series of rocks forming this *sierra*, resting on the mica-schists and slates of the Sierra Nevada, is a succession of black, white, and purple talcose schists at the base, which alternate with some beds of yellowish and porous limestone, and which pass through a considerable thickness of grey limestones and slates, and precisely where the fossils have been found, to the metalliferous limestone of Sierra de Gador, which appears to form the top of this interesting formation. The fossils found belong to the following genera:—*Myophoria* (*M. lævigata* and *M. Goldfussi*), *Hinnites*, *Monotis*, *Avicula* (*A. Bronni*), *Myacites*, *Rissoa*, and many others difficult to determine. The places where the fossils have been found are the following:—On the southern slopes of the Sierra de Gador, in the Rambla del Cañuelo, midway on the road from Felix to Marchal, and in the place named La Solana del Fondon, to the left of the River Andarax, following the track between the mine Sebastopol and the town of El Fondon.—Joaquin Gonzalo Y Xavier."—The Girvan Succession.—Part I. Stratigraphical, by Charles Lapworth, F.G.S., Professor of Geology in the Mason Science College, Birmingham. The Lower Palæozoic rocks of the neighbourhood of Girvan, in the south of Ayrshire, have long been famous for the remarkable variety of their petrological features and for the abundance and beauty of their organic remains; but the strata are so intermingled and confused by faults, folds, and inversions, that it has hitherto been found impossible to give a satisfactory account of the geological structure of the region. The most remarkable formation in this Girwan area is a massive boulder-conglomerate, several hundreds of feet in thickness, which forms the high ground of Benan Hill, and ranges throughout the district from end to end. Employing this formation as a definite horizon of reference, the author showed, by numerous plans and sections, that it was possible for the geologist to work out the natural order of the strata both above and below this horizon, and to construct a complete stratigraphical and palæontological scheme of the entire Girvan Succession. The development of the palæontological features of the several zones of life in this succession, and the demonstration of their correspondence with the zones already recognised in the synchronous Lower Palæozoic strata of Moffatt, the Lake District, Scandinavia, and elsewhere were reserved by the author for a second part of this memoir.—Notes on the *Annelida tubicola* of the Wenlock Shales, from the washings of Mr. George Maw, F.G.S., by Mr. George Vine. Communicated by Prof. P. Martin Duncan, M.B., F.R.S., V.P.G.S.—Description of part of the femur of *Nototherium Mitchelli*, by Prof. Owen, C.B., F.R.S., F.G.S. The specimen described consisted of the distal portion, probably about one-half, of a femur obtained from Darling Downs, Queensland, and received by the author from Dr. George Bennett. Its principal differences from *Diprotodon* are that it has no depression above the outer condyle, but in its place a rough longitudinal rising for the attachment of the same or of a homologous muscle; and the hinder surface of the condyle is transversely convex. The relative width of the post-condylar fossa resembles that in *Phascolomys*; and a further resemblance to the Wombats consists in the more equal prominence of the lateral boundaries of the rotular surface than in *Diprotodon* and *Macropus*. The bone differs from the corresponding part in the

Wombats by several subordinate characters, and the animal to which it belonged would seem to have been intermediate between *Phascolomys* and *Macropus*. From the size and characters of the bone, the author referred it to *Notctherium Mitchelli*; its breadth across the condyles is 5¾ inches.—On *Helicopora latispiralis*, a new spiral Fenestellid from the Upper Silurian beds of Ohio, U.S., by Mr. E. W. Claypole, B.A., B.Sc. (Lond.), F.G.S.

Chemical Society, June 15.—Dr. Gilbert, president, in the chair.—The following papers were read:—Note on β naphthaquinone, by C. E. Groves. The author has repeated the experiments of Liebermann (*Ber.* xiv. 1310) as to the preparation of the above substance from β napthol-orange, and fully corroborates the results of that chemist, but disagrees with him as to the economical value of the process. He has somewhat improved Liebermann's method by using less stannous chloride, but finds that even then it is more troublesome and tedious than the conversion of β napthol into the amidonapthol through the nitroso-compound, &c. The cost of Liebermann's process is four times as great as the one originally proposed by Stenhouse and Groves. In preparing either α or β naphthaquinone from the corresponding amido-compounds, the author prefers to use ferric chloride as the oxidising agent.—On some new compounds of Brazilein and Hæmatein, by J. F. Hummel and A. G. Perkin. Extract of logwood is dissolved in hot water and when cool, ammonia is added in slight excess. This solution, by exposure to the air, deposits a dark purplish precipitate of hæmatein, which, on purification, gave numbers indicating the formula $C_{16}H_{12}O_6$; by the action of cold sulphuric acid, an orange crystalline substance, $C_{16}H_{12}O_6SO_3$ was obtained. By the action of hydrochloric acid in sealed tubes, hydroxyl is replaced by Cl: $C_{16}H_{11}O_5Cl$), a similar body is produced by hydrobromic acid. Brazilein was prepared in a similar way from Brazil extract. It forms compounds which resemble those of hæmatein.—On the determination of nitric acid as nitric oxide by means of its reaction with ferrous salts, Part II., by R. Warington. The method is founded on that proposed by Schlœsing, but the nitric oxide is collected and determined by gas analysis, the gas being absorbed by caustic potash after successive treatments with oxygen and pyrogallol; great care was also taken to exclude all oxygen from the carbonic acid used.—On a new process of bleaching, by J. J. Dobbie and J. Hutcheson. The authors have investigated various methods of liberating chlorine by decomposing hydrochloric acid and chlorides with a weak electric current. The best results were obtained by moistening the goods with sea-water and passing them between two slowly-revolving carbon rollers, which were connected with opposite poles of a battery; sodium hypochlorite was formed in the fabric, and on immersion in acid the bleaching was effected. Results were also obtained with dilute hydrochloric acid. Pure hydrofluoric acid also bleaches when thus decomposed.

Physical Society June 17.—The Physical Society met in Oxford by invitation of the president, and after luncheon in the hall of Merton College, by kind permission of the Warden and Fellows, the health of the Society was proposed by the president, and responded to by Lord Rayleigh. The usual meeting was then held in the Clarendon Laboratory, Prof. Clifton, president, in the chair.—Dr. W. H. Stone exhibited and described an electro-dynamometer specially designed for measuring the currents used in the medical applications of electricity (NATURE, vol. xxvi. p. 201). Mr. Varley, Prof. Perry, and others, offered some remarks.—Mr. Bosanquet then described his application of the Faure accumulator charged by a dynamo-electric generator to the working of laboratory apparatus instead of the usual Grove, or other battery. The net result of his experiments is that the accumulators charged for two hours have sufficient energy to keep the apparatus employed running for a week, and hence it is unnecessary for him, as heretofore, to put up thirty Grove cells each day. Prof. Perry observed that a well-made Faure cell, having the minium laid on in a uniform coat, does not lose its charge nor develop local action, as is done by those accumulators in which the minium is put into holes in the plates.—Prof. W. G. Adams then took the chair while Prof. Clifton described some ingenious devices adopted by him in lecture experiments on electrostatics. These consisted of insulating glass stems with glass cups to hold sulphuric acid formed on the stems; also a form of key which, by rapidly succeeding contacts, brings the spot of light on the electrometer scale to rest without tedious swinging. He also described a form of lecture-galvanometer, sine or tangent, which could be readily shown in all its working to a large class, and exhibited a simple and inexpensive apparatus for measuring the focal length of a lens in six different ways, according to what is known about the lens. The results showed that the apparatus was very accurate in its indications.

SYDNEY, N.S.W.

Royal Society, May 3.—Annual Meeting.—The number of new members elected during the year is 46, making the total number of ordinary members upon the roll to date 475.—At the Council Meeting held on March 22 it was unanimously resolved to award the Clarke Memorial medal for the year 1882 to Prof. James Dwight Dana, LL.D., of Yale College, Newhaven, Conn., in recognition of his eminent work as a naturalist, and especially in reference to his geological and other labours in Australia, when with the United States Exploring Expedition round the world in 1836 to 1842.—During the year the Society has held eight meetings, at which thirteen papers were read, and three of the sections held regular monthly meetings.—At a meeting held by the Council on October 26, it was resolved that the Society should offer prizes of 25*l*. each for the best communication containing the results of original research or observation upon certain subjects to be set forth from time to time.—The Bill for incorporating the Society was approved by the Parliament of New South Wales on December 16, 1881.

BERLIN

Physiological Society, June 16.—Prof. Du Bois-Reymond in the chair.—Prof. Zuntz read a paper upon the value of amid bodies as animal nutriment, based on experiments which he made upon a number of rabbits. In each experiment he divided the animals that he was experimenting on, into two groups. One of these groups was fed with food-stuffs containing no nitrogen (starch and oil) and with various nutritive salts, while the other rabbits received, in addition to this food, a supply of amid bodies. The object of the experiments was to determine which, if any, of the amid bodies could replace the albumen of the food. Herr Zuntz managed to overcome the distaste of the animals for the monotonous, unstimulating diet (a difficulty which has often to be combated in a disagreeable manner in experiments of this kird), by also giving them small quantities of an alcoholic infusion of hay, and by giving the food that had been refused by the animal as pap or powder, in a firm friable form. The results of the experiments may be shortly summed up thus: Extract of meat, when added to the non-nitrogeneous food-stuffs, produced no effect upon the nutrition; the animals died in exactly the same time as without the extract. Asparagine likewise could not take the place of the albumen of the food, but the loss of albumen was about 20 per cent. less in the animals that were fed with the asparagine, in addition to their other food, than in those who were fed on non-nitrogenous food alone. An addition of a mixture of asparagine and some other amid bodies, *i.e.* leucine, tyrosine, and others, of which one might have presumed that they would together form an albumin-material during the process of digestion, had, as a fact, the exactly opposite effect of producing a remarkably larger loss of albumen than the non-nitrogenous diet of the other group of animals that were kept for purposes of comparison. In the same way the addition of the crystallising decomposition-products of albumen which were got by the action of pepsin, had a prejudicial influence, producing a greater loss of albumen. Probably an ammoniate was the active principle in both cases, as it is known to work destructively in the body upon albumen; but it is possible that the amid bodies themselves behaved like ammoniate. These experiments are to be pursued with other amid bodies and with decomposition-products of albumen.—Prof. du Bois-Reymond made some remarks upon Prof. Fritsch's late investigations as to the homology of the torpedo-electrical organ with muscles and mucous-cells, and on the development of the Torpedinea, the relative weights and the nerve-endings in the electric plates, and made some observations upon the question of the immunity of the electric fish against their own shocks. He especially drew attention to the fact that there are to be found in the intestines of electric fish, certain entozoa, which must either have an immunity against the shocks of their hosts, or, a question that has not yet been investigated, be altogether insensible to electricity.

Physical Society, June 23.—Prof. du Bois-Reymond in the chair.—Prof. Neesen showed a new mercury air-pump, made on the principle of the Topler air-pump, but with several alterations to facilitate the working.—Dr. Braun exhibited a somewhat modified Huyghens barometer, which had, both at the upper and at the lower meniscus of mercury, points for exact measurement, and which served to measure not only the variations, but also the amount of the air pressure.—Dr. Kaiser showed a moment-shutter for instantaneous photographs, in which, on pressing a small capsule with the hand, two pendant valves before the aperture are raised, and meet one over the other. The time during which the light can penetrate by the aperture into the apparatus, is 1-20th second. By a simple replacement in the apparatus, the mechanism can be so altered, that the light coming from above—that of the sky and clouds—acts a much shorter time than that from other objects, so that, with 1-20th second of illumination, the exposure for the sky is not excessive.—Prof. Neesen remarked, *à propos* of a former communication by Dr. Thiesen, on the deflection of projectiles, that in the case of the best German guns, this deflection amounts to one degree; thus, with a distance of 3000 metres, it is about 128 metres, a value which cannot be explained by the hypothesis of Dr. Thiesen.—The next meeting of the Society takes place after the holidays, on October 20.

VIENNA

Imperial Academy of Sciences, June 9.—E. Mach, on A. Guebhard's statement on equipotential curves.—L. Boltzmann, on the theory of gas-diffusion.—E. Heller and C. Della-Torre, on the distribution of the fauna in the high mountains of Tyrol.—E. Ratbay, Researches on the spermagonia of the Æcidiomycetes.—R. Andreasch, on mixed alloxantins.—On cyamidomalonic acid, by the same.—On dimethylglyoxylcarbamide, a product of reduction of Cholestrophæne, by the same.—W. Pscheidl, on determination of the coefficient of elasticity by bending of a rod.—G. Schmidt, on analogies.—C. Braun, a sealed packet, with the inscription, some suggestions to the technics and praxis of astronomical instruments.—L. Psæczolka, a sealed packet with the inscription, on the action of silicon on carbonic oxide in the recarburation in the Siemens-Martin process.—C. Natterer, on monochloraldehyde.—E. Lecher, on the absorption of radiant heat by steam of water and carbonic acid.—V. Uhlig, on the cephalopoda fauna of the strata of Wernsdorf.—On the strata of Wernsdorf and their equivalents, by the same.

June 15.—K. Fulkowsky, on the constituents of corallin.—B. Brauner, contributiou to the chemistry of the cerite metals.—E. v. Haerdtl, computation of the orbit of the planet Adria.

June 22.—Ph. Knoll, contributions to the theory of respiratory innervation (part 2); on respiration with artificial stimulation of the cervical part of vagus.—G. Stach, on the fossils collected in the Western Sahara, by O. Lenz during his journey to Timbuctu. They belong all to the carboniferous, and show analogies with the fossils of the Belgian limestone.—F. Steindachner, ichthyological contributions (part 12) on a new Ezemias species, *E. Holubi*, from the valley of the Limpopo River (Transvaal).—Th. Weinzweig, on the anatomy of laryngeal nerves.

PARIS

Academy of Sciences, June 26.—M. Jamin in the chair.—The president reported on the presentation of a commemoration medal to M. Pasteur on June 25, by a committee of friends and admirers. M. Dumas' address and M. Pasteur's reply are given in *Comptes rendus*.—A telegram from the Emperor of Brazil stated that comet Wells was visible on the 17th (June). On the 20th the tail measured 45°, and the nucleus was very bright.—On the reciprocal displacements of acids combined with oxide of mercury, by M. Berthelot.—Note on the preparatory works of the submarine railway between France and England, and on the geological conditions under which they are executed, by M. Daubrée.—On *débris* of mammoth found in the heart of Paris, by M. Gaudry. The locality is in the Rue Pagevin, the foundations of the new Hôtel des Postes. M. Gaudry showed a molar. Since Cuvier's time numerous remains of large quaternary mammals have been found in Paris, and human remains contemporary with the mammoth.—Mobile tableau of the different attitudes of the horse in any pace, by M. Marey. He describes a device of M. Cuyer, in which a jointed figure of a horse is fixed on a board; the hoofs are painted different colours; and placed on corresponding coloured and numbered spaces on sheets of paste-board, so that different phases of a pace can be represented. Direction is also given in placing the head, neck, body, and tail.—Action of low temperatures on the vitality of trichinæ in meat, by MM. Bouley and Gibier. Exposure of meat to a temperature of − 20° and even − 15° is sufficient to kill the trichinæ in it.—On the second comet of the year 1784, by M. Gyldén.—On the photographic spectrum of Comet I, 1882 (Wells), by Dr. Huggins.—On *Laminaritez Lagrangei*, Sap. and Mar., by M. de Saporta.—Experimental study of the conditions that allow of rendering usual the employment of the method of M. Toussaint for weakening the virus of charbon and vaccinating animal species subject to splenic fever, by M. Chauveau. Heating (according to certain rules) blood infected with bacteria, makes it a vaccinating liquid quite as sure as that of M. Pasteur. The temperature 43°-44° suffices. In an hour enough vaccine matter for 500 sheep can be prepared from one guinea-pig.—M. Lallemand was elected Correspondent in Physics in room of the late M. Billet.—On Eulerian integrals, by M. Tannery.—On Abelian functions, by M. Appell.—On the reduction of Abelian integrals to elliptic integrals, by M. Picard.—On the perforating machine of Col. Beaumont employed on the submarine railway, by M. Duval.—On the employment of zinc-carbon couples in electrolytes, by M. Tommasi. A reply to M. Berthelot.—On silicium, by MM. Schützenberger and Colson. Platinum plate or wire, heated to a white red within a thick layer of non-siliciferous lamp-black, gains weight, and has its fusibility increased, through fixation of silicium, which can only have come from the crucible. From various experiments, the authors infer that nitrogen, and probably also oxygen, have a *rôle* in the transport of silicium.—Action of bimolybdate of potash on some oxides; production of corundum and specular iron ore, by M. Parmentier.—Action of sulphuretted hydrogen on sulphate of nickel in acetic solution, by M. Baubigny.—On the supposed compound NH_2, by M. Combes. Having repeated M. Maumené's experiments, he gets only ammonia and carbonic acid.—On didymium, by M. Brauner.—Action of oxygenated water on the red colouring matter of blood and on hematosin, by M. Béchamp. Hemoglobin and hematosin behave, in contact with oxygenated water, as oxidable bodies. The blood contains two causes of decomposition as regards oxygenated water, viz. microzymas and hemoglobin.—On gastric juice, by M. Chapoteaut. Pepsine seems to him to be a combination of an albuminoid matter with an organic acid; (he hopes to prove this shortly).—On the differentiation of protoplasm in the nerve-fibres of Unionides, by M. Chatin.—On the sexual organs of *Ciona intestinalis*, by M. Roule.—The eye of *Proteus*, by M. Desfosses. It has retinal development, but no crystalline lens, nor any refractive organ; thus it cannot be compared with the eye of any vertebrate.—New example of alternating generations; œcidium of creeping Ranunculus [*Œc. Ranuncuacearum* (*pro parte*)] and Puccinia of roses (*Puccinia arundinacea*, Dc.), by M. Cornu.—On the disease of saffrons called "Death," by M. Prillieux.—On the petioles of Alethopteris, by M. Renault.—On the marine carboniferous of Upper Alsace; discovery of its relations with the culm or the plant carboniferous, by MM. Bleicher and Mieg.

CONTENTS

THURSDAY, JULY 13, 1882

THE GEOLOGY OF CHINA

China: Ergebnisse eigener Reisen und darauf gegründeter Studien. Von F. Freiherrn von Richthofen. Zweiter Band. (Berlin: Reimer, 1882.)

THE second volume of Baron Ferdinand von Richthofen's great work on China has just appeared. Five years have elapsed since the publication of the first volume, and two additional volumes are promised to complete the work, which when its maps and full index have been supplied, will be a great storehouse of observations in almost every department of Geology. Few geologists have enjoyed such opportunities of extended travel as have fallen to the Baron's lot. Already familiar with the rocks of a large part of Central Europe, he carried his knowledge and experience to the far west of North America, and did admirable service theie as a pioneer to those who have [come after him. Subsequently he set himself to explore the geological structure of the Chinese Empire, and he is now laboriously collecting and arranging the vast materials which he amassed in his wanderings through the almost unknown geological formations of that wide region.

His chapters are arranged in the chronological order of his journeys, and bristle with local details, which, however, are illustrated and made more readily intelligible by numerous sections interspersed through the text, as well as by sheets of coloured profiles. One of the most valuable features of the book for general readers consists in the clear summaries of geological data which for each great district are given in larger type. From these the salient points in the geological structure of the different provinces and their bearing on systematic geology may be gathered by those who have not time to read the voluminous narrative of details. The author confers a further and most welcome boon upon students by appending to his volume a final chapter of "Geological Results," wherein he gives a succinct but clear and interesting outline of what he conceives to have been the leading events in the geological history of China. As this outline is accompanied throughout by references to the pages where each subject will be found treated in ample detail, the reader sees at once where to turn for fuller information.

Baron von Richthofen divides the story of the geological evolution of China into three chief periods. (1) That of the formation and plication of the Archæan rocks; (2) that of the Palæozoic rocks to the end of the Carboniferous epoch; and (3) a vast continental period lasting from Palæozoic time up to the present day. The Archæan gneiss, in highly inclined beds with a persistent N.N.W. strike, is separated from all younger formations by a great abrasion and discordance. It is succeeded by a younger gneiss and by mica-schist, hornblende-schist, quartzite, marble, coarse conglomerate, sandstone, and green slates, some of which can be seen to lie unconformably upon it. These various crystalline masses underwent enormous plication and subsequent denudation before the deposition of the Palæozoic series upon them. They are succeeded by a vast mass of sedimentary material (12,000 to 20,000 feet thick) constituting the "Sinesian Series," in which arenaceous rocks predominate in the lower and calcareous in the upper portions. The occurrence of some forms of *Dikellocephalus* and *Conocephalus* and numerous brachiopods at the top of this series indicates that in part it represents the period of the Primordial Fauna of Europe, and the Potsdam Sandstone of North America. These interesting and important fossils will be fully described in a future volume of the work. It would appear that the denudation of the elevated area of crystalline rocks continued through the Silurian and Devonian periods. In the latter period, or at its close, considerable terrestrial disturbance took place, whereby a general upheaval of the whole area was effected, with plication and fracture in certain tracts. Next came the deposit of the Carboniferous Limestone and of the coal-bearing sandstones shales and marine calcareous bands (with *Productus semi-reticulatus*) which overlie the limestone. The existence of coal in China was known many years ago, and English steamboats have been in the habit of coaling in Chinese ports from the produce of native workings. But the vast extent and geological relations of the coal-fields have first been made known by our author. One of his maps gives a graphic representation of the enormous area of undisturbed country over which the nearly horizontal coal-bearing measures extend. There are at least two series of coals, one belonging to the true Carboniferous and the other to the Jurassic system.

The close of the Carboniferous period was marked by an equable uprise of the land towards the north and plication in the south, with the outbreak of volcanic eruptions. The result of these movements was the final and persistent transformation of the greater part of China into land. Among the oldest deposits of that ancient terrestrial area are the coal-bearing beds in the northern tracts of Chili and Shansi, which contain land-plants referable to the age of the Upper Jurassic rocks of Europe, and the coal-basin of Ta-tung-fu, the flora of which appears to be of Lower Jurassic age. Among the events of Mesozoic time was the outburst of porphyritic eruptive rocks, with which are associated masses of breccia and tuff.

Some of the most generally interesting portions of the volume are those that deal with the origin of the present surface-features and superficial deposits of China. The author traces the history of the vast depression forming the great plain or basin of China, and of the volcanic activity which took place there and in other parts of the empire during Tertiary and Post-Tertiary time. Those who have seen his first volume will be prepared to find that he ascribes much of the existing configuration of the Chinese Empire to prolonged denudation since the Post-Carboniferous elevation of the region into dry land. He distinguishes three great climatic periods during which the denudation proceeded:—(1) The period of Erosion, in which the existing contours of the firm surface under the Loess were carved out; (2) the period of the Steppes, when the peculiar conditions of the Central Asiatic steppes spread over Northern China; and (3) the period of the Loess, or the duration of the existing meteorological conditions, whereby the former steppe-land is desiccated and converted into loess-land. He is disposed to regard the steppe-period as contemporaneous with the Ice-Age in Europe; but no traces of glaciation occur in Northern China. He reiterates his well-known views regarding the origin of the Loess, and cites a number of authors who have elsewhere been led to the same conclusion, that the deposit is essentially a subaërial one, formed by long-continued wind-drift with the help of vegetation. That this conclusion is true for the high arid regions of Asia and Western America cannot be doubted by any attentive observer who has watched what is now daily going on in either of these regions. In his first volume the Loess was spoken of as "subaërial"—a term altered in the present volume into "æolian," which the author noticed for the first time employed geologically in Mr. Clarence King's Report on the "Exploration of the Fortieth Parallel." It is a very good term, but of much older date than the Baron supposes, for he will find it in Captain Nelson's suggestive paper on the Bahamas, published as far back as 1852.

In a section "Upon Abrasion and Transgression," the author insists upon the paramount influence of the sea as an agent in planing down the surface of the land. "Regional abrasion," he affirms, "can only be accomplished by the advance of the breakers." This used to be also the opinion of geologists in Britain, who from their insular position and stormy climate had exceptional advantages in studying marine denudation. But there is now a wide-spread conviction among them that the part played by the sea in the levelling of land has been much exaggerated. For the production of a plain of erosion the co-operation of the sea is no doubt necessary. But the abrasion of the land down to the level of the sea is the work of the subaërial agents, and only the final touches are given by the breakers. A "plain of marine denudation" is the surface down to which a terrestrial area has been reduced. Its position and form were mainly determined by the lower limit of breaker action. But by far the greatest amount of abrasion was done by wind, rain, frost, rivers, glaciers, and other subaërial forces, which in fact reduce the land to the level at which breaker action could take effect. Oscillations of level might doubtless assist the sea, but any such help would be of comparatively trifling value.

In a final section the author gives a sketch of the coal-fields of Northern China, and analyses of sixty varieties of coal which will be found of some economic interest. He must be congratulated on the appearance of this second volume. The task he has undertaken is a most laborious one; but the method he follows is well suited to combine scrupulous attention to details and general intelligibility and interest. Without ample details his work would be of comparatively little value to those who shall hereafter travel over the same ground to verify, modify, or extend his observations. On the other hand, mere details would repel ordinary readers; but Baron von Richthofen skilfully caters for them in his large print summaries, where they find the points so well put before them as to induce probably not a few to attack the voluminous detail. It is to be hoped that the Baron may find leisure enough to enable him soon to complete the work.

ARCH. GEIKIE

OLD ENGLISH PLANT-NAMES

Sinonoma Bartholomei. A Glossary from a Fourteenth Century Manuscript in the Library of Pembroke College, Oxford. Edited by J. L. G. Mowat, M.A. (Oxford: Clarendon Press, 1882.)

IT is announced that "under the general title of 'Anecdota Oxoniensia,' it is proposed to publish materials, chiefly inedited, taken directly from MSS., those preserved in the Bodleian and other Oxford Libraries to have the first claim to publication." The materials will be issued in four series—(1) Classical, (2) Semitic, (3) Aryan, (4) Mediæval and Modern; and the work named at the head of this notice is the first of the fourth series.

Of the general value of these mediæval glossaries it is of course unnecessary to speak. The "Promptorium Parvulorum" (c. 1440), issued by the Camden Society in 1865, and the Early English Text Society's "Manipulus Vocabulorum" (1570) and "Catholicon Anglicum" (1483)—the latter one of the most recent as it is one of the most useful of their publications—may well be styled priceless records of the English language. Our only regret is that the whole work from which the "Sinonoma" is taken has not been made accessible, as Mr. Mowat's brief preface renders it abundantly evident that it contains much which would be useful, and probably also amusing—if we may judge from the few sample extracts which he gives, one of which refers to the "pulvis pro instrumento illo bellico sive diabolico quod vulgaliter dicitur *gunne*."

The editor tells us that "it was in the plant-names chiefly that [his] interest lay"; and this is easily accounted for when we see how large a proportion words of that class bear to the whole glossary. We have lately had from Prof. Earle an interesting little volume on "English Plant-Names from the Tenth to the Fifteenth Century"; while the "Dictionary of English Plant-Names" by Mr. Holland and myself, of which the third and last part is nearly ready for issue by the English Dialect Society, is, I hope, fairly complete for such names from the days of William Turner downwards. Some day it will, I trust, be found practicable to combine these two, adding to them the names found in "Promptorium Parvulorum" and in other early glossaries, both published and unpublished; and the "Sinonoma" will form a useful adjunct to such a work. There can be no doubt that Mr. Earle's book and the "Dictionary of English Plant-Names" will be found to supplement one another to an extent hardly suspected by Mr. Mowat, who, in spite of his interest in plant-names, does not seem to have consulted the latter work. For instance, he gives "Allium agreste, *i.* crawegarlek," and adds in a footnote "probably meadow-saffron." A *meadow* plant would hardly be termed *agreste;* and a reference to the "Dictionary" would have identified the crowgarlic with *Allium vineale*, which is so called by Turner ("Names of Hebes"), and is, or was, sometimes—*fide* Lisle's "Husbandry" (1757)—as troublesome a weed among corn in England as it is in the continental vineyard from which it took its specific name. Later on (p. 38) we find Mr. Mowat saying of "Allium sylveste" [sylvestre] that it "can be no other than meadow saffron." Here again the designation *sylvestre* should have put the editor on his guard; the reference to Fuchs which he gives shows clearly that some *Allium* was intended, and tracing the synonymy through Bauhin to Linnæus, we find that *A. vineale* is the species meant. Even apart from this evidence, it is obvious that the "sellers of simples" who substituted another herb for *Teucrium Scordium* would have selected one that had a similar smell, and not one like the *Colchicum*, which has no such odour. Mr. Mowat rightly identifies the "gosegresse" of the "Sinonoma" (p. 41) with *Potentilla Anserina;* but it is hardly accurate to say that it is "generally cleavers" (*Galium Aparine*). The "Dictionary of English Plant-Names" shows that the *Potentilla* is at least as frequently called goosegrass nowadays; and it is the "Gosgres" of the Old English Medical MS. printed in Archæologia, vol. xxx. (p. 408)—a glossary containing many plant-names which have been too little noticed. "Caputpurgium, *i.* stafisagria," is not *Pedicularis,* as glossed by Mr. Mowat—a plant supposed to favour the growth of lice—but the Stavesacre, which has been used for destroying them since the days of Pliny. Similarly "Calendula, *i.* solsequium," is not Caltha, but the Marigold, *Calendula officinalis;* this is made quite clear by the description under Kalendula, which may be cited as an example of the capital diagnoses which the glossary contains. "Kalendula est herba crescens in hortis portans florem rubeum vel croceum de quibus floribus faciunt sibi juvenculæ coronas, solsequium idem."

To make a glossary of this kind useful to other than English-speaking students, the plants should be identified with their Latin as well as by their English names. Even in America, the mention of the cowslip would suggest, not *Primula veris* but *Caltha palustris.* Mr. Mowat says (quite correctly) that "pigle, pagle, paigle seems to be the regular old name for cowslip"; and he seems to imply that the entry "pigle, *i.* stichewort," may also refer to *Primula veris.* But a previous entry, "Lingua avis, *i.* stichewort, *i.* pigle," is quite sufficient to confirm the natural conclusion that by stitchwort *Stellaria Holostea* (which is still commonly so called) was intended; and this plant is called pigle by Gerard in his appendix of "names gathered out of ancient written and printed copies, and from the mouthes of plaine and simple countrie people." Under "Serpillum" we find the name "pelestre," which Mr. Mowat queries "palustre?" but this is a form of Pellitory, already given on p. 34—"Piretrum, pelestre idem"—the name "Piretrum" showing that *Anacyclus Pyrethrum,* not *Parietaria,* was intended; the Anacyclus also figures in the Glossary under the name of "Dentaria," in allusion to its former use in toothache. An instance of the insufficiency of English names is given in the gloss of "Umbilicus veneris, *i.* penigresse," as "penny-grass, pennywort"; it is of course *Cotyledon,* not *Hydrocotyle,* which is here meant, though the vernacular names are common to the two plants.

In most cases, however, where Mr. Mowat has given a modern synonym, it is correct; but I do not quite understand why only comparatively few plants are identified, as the identifications are by no means confined to cases of special difficulty. Some very obvious explanations are duly set forward, while in more doubtful cases help is often not forthcoming.

In the volume of Plant-Names which I hope to prepare for the Early English Text Society, I shall try to identify as far as possible all the plant-names, both English and Latin, with their modern scientific equivalents. This will be a tedious work, and one in which mistakes are certain to occur; but a foundation will then have been laid for the future production of a comprehensive work on English plant-names which shall take in all, from the earliest to the most recent. When such a work comes to be done, the great value of collections like this of Mr. Mowat will become apparent.

JAMES BRITTEN

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Analysis of the Tuning Fork

MR. HERMANN SMITH, in a letter in NATURE last week, commenting upon my paper read before the Physical Society on June 10, of which you gave a short report, offers some very cogent experiments in support of the evidence I have endeavoured to give, that the tuning-fork does not communicate its sonorous vibrations to a sounding-board through a *ventroid,* as we find generally accepted upon the theory of Chladni. In remarks upon my paper at the Physical Society, Lord Rayleigh suggested that this matter could be demonstrated by cutting a tuning-fork out in both ends of a long steel bar in the manner I had done, for an experiment, in one end only; we might then observe if sonorous vibrations would be communicated through either of the prongs of the double fork, at the opposite end to that set in vibration. In the following week I constructed such a fork, and I found that either of the non-vibrating prongs, when the opposite ones were set in vibration, would form a perfect stem to the fork, and communicate sonorous vibrations just as well as a single stem. In this case it will be seen that the prongs, which may be considered to form the stem, lead directly to the places on the fork pointed out as its nodes by Chladni. It appears, therefore, evident that a node may communicate sonorous vibration to a sounding-board.

After reading my paper Dr. Stone told me in conversation that he had constructed a tuning-fork with a rod projecting at right angles to the open space between the prongs, and directly from its stem, and that this rod communicated sonorous vibrations from the fork to a sounding-board nearly as perfectly as the direct stem. This modified form of fork I also made by screwing a stem into my experimental fork, which was made in the end of a flat steel bar. I found it to act as Dr. Stone had stated. These experiments appear further to show that sonorous vibrations are communicated through nodes to sounding-boards. If we may apply this principle to stringed instruments, we must look rather to the bridge than the transverse motion of the string, as the communicator of the sonorous vibrations which produces the note. I may say that the discussion of Chladni's theory was not the object of my paper, the purpose of which was to show that the sonorous vibrations forming a note are possibly compounded of vibrations of much smaller amplitude than generally assumed, which was perhaps better demonstrated by other experiments.

W. F. STANLEY

The Mount Pisgah (U.S.) Stone Carvings

THE number of NATURE dated June 15 (p. 160) contains some statements relating to the curious stone carvings discovered by Mr. M. S. Valentine in the neighbourhood of Mount Pisgah, North Carolina, and now exhibited by him in Europe. Before leaving the United States, Mr. Valentine brought his specimens to Washington, in order to have them examined by Prof. Baird, the Director of the United States National Museum, and by myself. I am therefore enabled to express an opinion concerning them. Having been for many years in charge of the largest existing collection of North American antiquities, I can safely assert that they are totally abnormal in character, that is, unlike any pre-Columbian stone carvings thus far found in the United States. They neither show the characteristics of the stone sculptures discovered in mounds, nor do they resemble the well-known specimens of modern Indian art. In short, they are not typical at all, unless, indeed, we deem them sufficiently important to form a type for themselves. Such an importance, however, I cannot concede to them, believing that they originated in comparatively modern, certainly in post-Columbian, times, and were made by a few individuals of the Indian, or, perhaps, even of the Caucasian, race. The rude attempts at imitating animals of the Old World are conclusive evidences that the makers either had seen such animals, or knew at least that they existed.

The carvings, it should further be taken into account, are executed in soft potstone, a material easily yielding to the effects of exposure, and hence a short lapse of time would have sufficed to give them the appearance of real antiquities. In fine, I consider these carvings as a modern intrusion, and would deem it an extremely hazardous attempt to make them the basis for speculations bearing on the ethnology of North America.

CHARLES RAU,
Curator Department of Antiquities,
U.S. National Museum
Smithsonian Institution, Washington, D.C., June 27

The Influence of Light on the Development of Bacteria

IN NATURE for July 12, 1877, there appeared a short communication from Messrs. Downes and Blunt summarising the conclusions at which they had arrived as the result of investigations on the influence of light on the development of lower organisms. The experiments were described in detail in the *Proceedings* of the Royal Society for 1877 (vol. xxvi. p. 488), and were considered by them to show that light is inimical to the development of bacteria in Pasteur's solution; but that for the full effect direct insolation is needed. Exposure to the sun's rays, according to them, may simply retard development, or it may completely sterilise the solution, by killing bacteria or their germs contained in it. In a second paper read before the Royal Society (*Proceedings*, vol. xxviii. p. 199), some further experiments were detailed, which, however, did not, I venture to think, do much towards settling the difficulties of the question. In the same volume of the *Proceedings* (p. 212) Prof. Tyndall supplied observations of his own, which confirmed the conclusions of Messrs. Downes and Blunt, in so far as the retardation of development was concerned, but differed on the point of sterilisation by bacterial destruction being attainable by insolation. At the last meeting of the British Association, Prof. Tyndall returned to the subject (NATURE, September 15, 1881), and related some further experiments confirming what he had previously stated.

I have recently made a considerable series of experiments, with the hope that under our bright Australian sun I might get results decisive on the point of difference between these inquirers and also confirming or negativing the result on which they were agreed. I made use of Cohn's solution as the cultivation fluid and common one-ounce phials as the vessels. The solution was inoculated with a small quantity of fluid swarming with bacteria (*B. termo*), the bottles plugged with cotton wadding and exposed fully to the sun. Some of the experiments were made in the hottest weather of February and March, and the later in April. To begin with, I simply placed the bottles on the outside of a window-sill, on which the sun shone during the greater part of the day, a temperature of 124° F. being noted on one occasion, and that probably not the highest reached. My first results seemed fully to confirm the conclusions of Messrs. Downes and Blunt, complete sterilisation apparently being sometimes attained, at least as far as bacterial growth was concerned, the destruction of mould spores, as also noted by them, not being so easily accomplished. Suspecting at last that the effect might possibly be due as much to elevation of temperature as to any special chemical or other action of the sun's rays, I varied my procedure. I was led to do this in part by the circumstance that I had not seen diffused light check in any way the bacterial growth, when the solution exposed to it was kept at the same temperature approximately as that in other bottles closely wrapped in brown paper. It did happen, indeed, that the exposed solution became opalescent *sooner* than that which had been guarded. The method ultimately adopted was, to suspend the bottle outside of a window, and the particulars of one experiment will make clear what resulted, and show the general method. On April 6, at 2 p.m., the weather being bright but cool, these bottles, containing each two drachms of inoculated solution, were suspended outside of a window. The 7th was cloudy, the 8th bright and cool; and on the 9th, which was bright and warm, all were still found transparent, and, at 9 a.m., one was brought in out of the sun. On the 10th, which was also bright, another was taken in at 9 a.m., the one which was left out showing, at that time, faint signs of cloudiness. A thermometer hung up beside it marked a temperature of 98° F. Next day, the 11th, at 9 a.m., the exposed solution was quite milky, the others just beginning to show traces of opalescence, the one removed on the 9th being least advanced. This experiment, even by itself, was almost decisive. It established the fact that insolation by itself does not prevent the growth of bacteria in a perfectly transparent medium, and does not even retard it, relatively to the time needed in solution less exposed, but kept at a rather lower temperature. In another experiment I found two bottles continuously exposed to the sun during two bright days, become milky, the bacterial growth, in fact, only beginning then, no trace of cloudiness having shown itself during five previous days which were dark and cold.

The conclusion I came to of necessity was, that the bacterial development was mainly, if not wholly, dependent on temperature. On referring to a paper by Dr. Ed. Eidam, in Cohn's *Beiträge zur Biologie der Pflanzen*, Heft iii., I found that he had proved that the *bacterium termo* passes into a torpid condition (Wärmestarre), when exposed to a temperature of between 40° and 45° C. (104°–113° F.); is killed by seven days exposure at 45° C., by fourteen hours at 47° C. (116°·3 F.), by three to four hours at 50°–52° C. (122°–125·6° F.), and by one hour at 60° C. (140° F.). In this country there need be no difficulty in getting a heat in the sun, greater than even the highest of these; and I should think it possible enough in England, on a hot summer day, to get a temperature in exposed situations considerably over 104° F., sufficient to paralyse the bacteria, or even to kill them, if the exposure was long enough continued. Any explanation of the difference between the results of Messrs. Downes and Blunt, and those of Prof. Tyndall, on the point of complete sterilisation, is simply that, while they used small test-tubes, his solutions were contained in flasks, and that the larger body of fluid less easily reached the highest temperature attainable under the conditions. The different results, with very small and larger tubes, observed by the former, and to them evidently inexplicable, if not simply accidental, is best explained on the same principle.

It is true that Prof. Tyndall agrees with the other inquirers in disclaiming the notion that the apparently inimical influence of light can be ascribed to difference of temperature; but it is evident that it had not occurred to them, that any possible elevation of temperature could act otherwise than by favouring bacterial growth and multiplication. This is plain, from the words used by Messrs. Downes and Blunt (*Proceedings*, vol. xxvi. p. 491), when, trying to account for some anomaly, they remark that "external conditions—notably temperature—may retard or counteract the preservative quality of the solar rays. It must be understood, however, that the putrefactive tendency of warmth does not, in our experience, with this solution at least, override what we termed the preservative quality of light; for, provided that there was the full amount of sunlight, we have preserved tubes exposed *continuously* from day to day as readily in hot weather as in cool." Prof. Tyndall, in his recent paper, speaks of his flasks having been exposed to strong sunshine for a whole summer's day; and, with reference to the more rapid occurrence of turbidity in those which had been shaded, adds: "This result is not due to mere difference of temperature between the infusions. On many occasions the temperature of the exposed flasks was far more favourable to the development of life than that of the shaded ones."

I feel the boldness of criticising the conclusions aimed at by such a famous investigator as Tyndall, and all the more when these are in accord, in the main, with those of other inquirers, the joint results having hitherto, to all appearance, been accepted as unimpeachable. I do so only after careful observation and consideration, and with the hope that further investigations, made with due precautions, will establish the correctness of what I have here stated. My researches in detail will be brought before the Royal Society of Victoria at the next meeting, and I will take the liberty of forwarding you a copy of the paper when printed, and of distributing a few others. It contains an account of experiments for the purpose of testing the action of sun and air on dried bacteria, which have some interest, but which the fear of trespassing unduly on your space prevents me from entering on here. JAMES JAMIESON

Melbourne, May 22

Fireballs observed in the Netherlands

IN the well-known "Meteoric Astronomy" of Dr. D. Kirkman, p. 67, is to be found the following note, on the occasion of the interesting shower of dust and aërolites in Calabria on the 13th and 14th of March, 1813. "The date of this remarkable occurrence is worthy of note, as a probable aërolite epoch. From the 12th to the 15th of March we have the following falls of meteoric stones. . . ." &c. (7 cases).

In reference to this note it may interest your readers that on the night of 12-13 March last two great meteors were observed in two different places in the Netherlands. The first observation, made near the village of Haren (four and a half kilom. S. of Groningen), by the schoolmaster, Mr. H. Bos, at 1 a.m., refers to a bright fireball, shining with a splendid "bluish red" light, illuminating the night, leaving a violet train, which lasted some moments. The path seems to have been from a point not far beneath the zenith, in an azimuth of 115° to another at 108° azimuth, and had a length of 45°, which was traversed by the phenomenon in 4 or 5 seconds. After 85 seconds—measured afterwards by means of a watch and by the distance of the objects which the observer had passed, going with a known velocity—a full detonation, like a distant cannon-shot, was heard in the same direction.

On the same night, and at the same hour, another fireball was seen near the village of Bergen, in North Holland. The schoolmaster, J. Francken, gives me the following indications of its path, found by him after having interviewed the observer. It went from N.E. in altitude of 50° to S.E. in an altitude of a little less than 40° It is therefore impossible that this phenomenon should be the same as the former, the direction of the course being opposite. A second observer gave nearly the same direction.

It is worthy of remark that another violet meteor had been seen near Haren on March 12 at 8 p.m. in the S.W.[1]

A fourth meteor of the greatest size, described as being as great as the full moon, was seen by three policemen, from whom I have received tolerably harmonising records, though they were standing in different positions in the town. The time of appearance was May 1, at 4 a.m. precisely, or perhaps three minutes afterwards, and the direction of the course was S.S.E. to N.N.E. It was described by one of the observers as beginning like a shooting star (though already lightening the sky), falling downwards and rising again in a curve from S.S.E. to N.N.E., increasing in the meanwhile to a great ball of a splendid purple light, and showing a train of a silvery colour. The phenomenon lasted 50 seconds (?) measured by a watch. No sound was heard. The disappearance was instantaneous. It is uncertain if an explosion was really observed. The altitude seems to have been at the beginning, and at the end point perhaps 10°, somewhat higher in the middle, as I have attempted to determine *in loco*. The second observer estimated the duration of the phenomenon to be 13 seconds. Even when this is accepted, the body must have been very distant, and of a great volume, though increased apparently by irradiation.

The same morning, at 3h. 45m. a.m. there was also seen a great meteor, going from W. to E. near Enumatil (8 kilom. W.), and at Assen (S. from Groningen). It seems not to be identical with the former. At Assen there was heard a buzzing sound. The Enumatil observers compare the phenomenon, whose colour was white with a red train, to a drum-major's staff. The Assen observers speak of a bluish train or tail, which seemed to be smoke. The same was seen by the sluice-keeper, G. Mulder, at Veenhuizen (W. of Assen), who heard also the buzzing sound, and gives also the direction, W.—E. The ball passed S. of the zenith (Assen).

Still another great fireball was observed at Bourtange (S.E. of Groningen) at 5h. 12m. (local time) a.m. on the same morning. It had a quick motion from S.W. to E. It gave the impression of being very near the earth, only some meters above the houses. It seems to me uncertain whether it was a globulous lightning or a true fireball. The phenomenon showed a fiery tail and exploded without any sound.

Recapitulating, there seems to have been observed the following fireballs of great size :—

March 12, 8 p.m. (Groningen M.T.) at Haren.
,, 13, 1 a.m. ,, ,, ,,
,, 13, ,, ,, Bergen (N. Holland).
May 1, 3.45 ,, ,, ,, Enumatil.
,, ,, ,, ,, Assen } Probably
,, ,, ,, ,, Veenhuizen } the same.
,, 4, ,, ,, ,, Groningen.

Finally a fireball or a globulous lightning.

May 1, 3 45 a.m. (Groningen M.T.) at Bourtange.

Groningen, June 19 H. J. H. GRONEMAN

---

[1] In the German journal, *Sirius*, edited by Dr. H. J. Klein, Bd. x. (1882), p. 40, is mentioned likewise a fireball of the full moon size, from March 13, 1875, by Mr. T. Köhl.

Aluminium for Movable Coils

AT the Oxford meeting of the Physical Society, after Dr. W. H. Stone's interesting description of an electrodynamometer designed for medical purposes with the movable coil, made of aluminium wire for the sake of lightness, I took the liberty to remark that about eight years ago Dr. Werner Siemens had made use of aluminium wire for the movable bobbin of his *dynamo-relay*.

I was then under the impression that this fact was probably not known in this country; a friend has, however, since called my attention to a short paragraph in the *Telegraphic Journal* of 1878, p. 53, in which it is already mentioned.

One of these dynamo-relays was shown working at the Paris Electrical Exhibition, and Messrs. Siemens and Halske have made use of the same principle in their so-called *soot-recorder* (see *Telegraphic Journal*, 1878, p. 90), an instrument well suited for the registration of currents of varying direction and strength.

At the meeting I further said that in some of the coils made of very thin aluminium wire, I had found an increase of resistance after the lapse of some time, and that this increase was proved to exist at the place where two lengths of wire had been joined by twisting them round each other.

Some experiments were afterwards made to coat the ends of the wire with an electrolytic deposit of copper, and then solder them together; but the best and most natural way to overcome the difficulty is to make the coil all of one length of wire, and thereby dispense with all internal joints.

A similar increase of resistance at the place of contact between aluminium wire and mercury I had already observed several years previously; the cause of it seems to be the formation of a very thin film of aluminium oxide on the surface of the wire.

I have been led to make the above remarks after perusing the closing paragraph of Dr. Stone's article in NATURE, vol. xxvi. p. 201. EUGENE OBACH

Woolwich, July 3

The Recent Weather

THE article published in NATURE, vol. xxv. p. 225, entitled "Recent Weather," attracted attention from meteorologists in China from the fact that the extraordinary character of the season therein discussed was observable in China also In my Report on the Health of Wenchau, I referred to the unprecedentedly high reading of the barometer in this part of the world, at the same time that a like phenomenon was observed in Western Europe.

NATURE records that November last showed the highest thermometrical range that has been known since thermometers came into use. On referring to the tables of Dr. Zrightsche (director of the Belgian Observatory at Peking), I find that the mean temperature at Shanghai of that month for a period of twelve years falls considerably below that of the record for November last; and finally we learn from NATURE that the winter of 1881-82 in Western Europe was an "open one," which was the case in Eastern Asia; the port of Tientsin, for example, having been closed by ice later, and opened to navigation earlier than usual. When the meteorological reports are all gathered in, it will be found that the abnormalities which characterised last winter were coincident with like phenomena in this part of the world. D. J. MACGOWAN

Wenchau, May 17

"Megaceros Hibernicus" in Peat

My friend, Dr. Leith Adams, has given it as his opinion that the Irish elk is only found in the clay or marl under the peat, while I contended that some of them occur in the peat, this opinion being formed from reports of finds in the counties of Limerick, Carlow, and Wexford, also from the colour and appearance of the bones; still I could not be positive, as I had not myself seen the bones raised out of the peat. Last week, however, I heard from Capt. Woodrift, Kilowen Inch, Co. Wexford, that he had found an elk's head in the peat, and I went to see it. It was lying on its back altogether in the peat, except some of the points of the horns. The portions in the clay under the peat were quite hard, while those in the peat were soft, but became quite hard a short time after they were taken out.

The "Elk Hole" at Kilowen is a very remarkable place, because, although very small, not 200 yards in diameter, yet at the present time the remains of over ten skeletons of elks have been taken out of it; while in the undisturbed portion of the bog there are probably other skeletons. A few miles to the south-west of Kilowen there is the small bog of Axe, in which the remains of the *C. megaceros* has also been found.

Ovoca, July 8 G. H. Kinahan

Perception of Colour

Happening to be reading out of doors, while the sun was shining on my book, I noticed that patches of weed on the lawn appeared peculiarly conspicuous in their difference of tint from the grass. The same patches of weed close-cropped to the level of the grass were ordinarily scarcely observable from difference of colour. Now, as I looked up from my book—my eyes dazzled with the glare—they appeared to me to have a strong blue tint. My attention thus being drawn to the point, I extended my observations, with the following results, which, if new, will doubtless prove interesting to some of your readers. I found that if the eye was exposed for two or three minutes to the action of a very strong light, *by looking at a sheet of white paper*, while bright sunshine fell on it, the capacity of the eye for perception of colour was curiously modified, under certain conditions. For example: if, on the instant after the exposure of the eye to strong light, as described—solarisation I will call it—flowers of various colours, placed in a shady part of a room were examined, a pink rose appeared the colour of lavender; dark crimson Sweet William, almost black; magenta Snapdragon, indigo; scarlet Poppy, orange; the eye was, in fact, red-blind. After a minute or two, the eye recovered its normal sensibility to red, and the flowers assumed their natural colour.

In order to ascertain that the mal-perception of colour, under the conditions described, was due to the action of strong light on the eye, and not to any other circumstance, I repeated the experiment, allowing the solarisation to take place on one eye only, the other eye being kept shut until the moment of making the observation. I then found, as before, that the solarised eye was red-blind to objects in a subdued light for a minute or two after solarisation, but sensitive to blue, and in less degree to yellow, while the non-solarised eye was perfectly normal in its perception of all the colours. By alternately closing and opening the solarised and non-solarised eye, the difference in colours perceived by the two eyes was extremely striking—the rose was, as seen by one eye, pink, by the other eye, blue. It must be remembered that the effects described were produced when the flowers were observed in a room not strongly lighted.

When a corresponding experiment was made with the flowers *in the sunshine* instead of in the shade, it was found that a reverse effect was produced—that every colour, and red particular, was intenser to the solarised eye than to the non-solarised eye—as was readily seen by alternately shutting and opening them. To the solarised eye a red rose-bud was deep red, to the other eye light red. The red of the poppy was deeper and more vivid to the solarised eye. A calceolaria was orange chrome to the solarised eye, lemon chrome to the non-solarised eye. A viola was dark violet to the solarised eye, a colder tone of blue to the non-solarised eye.

I found that after the insensibility to dimly lighted red and orange (the effect of solarisation) had worn off, a reverse condition succeeded, for example, venetian red, which was a dirty brown, as seen the instant after solarisation, appeared gradually to change to a full vermillion. I found also that portions of the solarised eye that had escaped the solarising action behaved like the non-solarised eye. I leave the explanation of these slight observations to those within whose special field of study they naturally fall, only remarking that the power of the eye, fatigued by solarisation to perceive blue light, and light of no other colour, under the conditions described, seems to suggest that the eye, like almost all matter sensitive to light, is more sensitive to blue rays than rays of lower refrangibility.

Lancing, July 10 J. W. Swan

WATER-JET PROPELLERS

Very early in the history of steam navigation, attempts were made to employ the "hydraulic" or "water-jet" propeller. About 1782 Rumsey began to work in this direction, using a steam-engine to force water out at the stern of a boat, the inlet being at the bow. His experiments are said to have extended over twenty years, but led to no practical result. Another American, named Livingston, applied the same principle of propulsion in a different manner. A horizontal wheel, or turbine, was placed in the bottom of the boat, near the middle of the length, the water was admitted from beneath it, and expelled from the periphery of the wheel through an opening at the after part of the boat. In 1798 a monopoly was granted to Livingston for twenty years by the State of New York, on condition that within a given period he produced a vessel capable of attaining the speed of four miles an hour. This condition was not fulfilled, and, as is well known, the first successful steamers built in this country or abroad were propelled by paddle wheels. This form of propeller alone was employed for nearly forty years, during which period steam-ships increased greatly in numbers, size, and speed, proving themselves well adapted not merely for service on inland and coasting navigation, but also for ocean voyages. Just when the Transatlantic steam service had been successfully commenced by the *Great Western* and *Sirius*, both paddle steamers, the screw-propeller began to threaten the supremacy of the paddle-wheel; and the success of the *Archimedes* in 1840 led to the adoption of the screw in the *Great Britain*, as well as the construction of the screw sloop *Rattler* for the Royal Navy. Soon after came a revival of the water-jet propeller by the Messrs. Ruthven of Edinburgh. In 1843 their first vessel was tried, attaining a speed of about seven miles an hour. Ten years later a fishing-vessel was built on the same principle, and exceeded nine miles an hour. Several other river steamers and small craft were constructed with jet-propellers in the period 1853-65, but they were all comparatively slow, and the plan did not grow into favour either as a substitute for the paddle-wheel or the screw.

There were certain features in the jet-propeller which recommended it to the judgment of many naval officers who had witnessed the trials of vessels so fitted; their influence led the Admiralty in 1865 to order the construction of a small armoured vessel, appropriately named the *Waterwitch*, which was to be fitted with Ruthven's propeller. Admiral Sir George Eliot was one of the principal advocates of a trial of the new system, in which he has always continued to take a great interest. In the German navy, trials of the Ruthven system have also been made on a small vessel named the *Rival*, and experiments of a similar nature have been made in Sweden. At the present time Messrs. Thornycroft are building for the Admiralty a torpedo-boat, to be propelled by water-jets, the trials of which are awaited with interest, since they will furnish another comparison between the performances of the hydraulic propeller and the screw.

The Ruthven system agrees in its main features with the proposal made by Livingston forty years earlier. As an example the arrangements of the *Waterwitch* may be briefly described. Openings are made in the bottom of the ship amidships, to admit the water into a powerful centrifugal pump or turbine, the axis of which is vertical.

The main engines drive the turbine, expelling the water with considerable velocity through curved pipes or passages leading to "nozzles" placed on each side at the level of the water-surface. When the vessel is going ahead the jets are delivered sternwards; if it is desired to move astern the engines are not reversed, but valves are operated in the outlet pipes, and the jets are delivered through the forward ends of the nozzles. These motions of the valves can be made from the deck by an officer in command. If desired, the jet on one side can be delivered ahead, and that on the other side astern, the vessel then turning without headway. This power of control over the movements of the vessel, without reversing the engines, is one of the chief advantages claimed for the system; and it is undoubtedly of value, especially in war-ships. Another advantage claimed for the jet-propeller is the power of turning it on an emergency, into a powerful pump, by which large quantities of water can be discharged from the interior of a ship that has been damaged in action. This latter feature cannot be regarded as of primary importance, however, seeing that modern war-ships are minutely sub-divided into water-tight compartments, and must depend for their flotation upon the integrity of the bulkheads and other partitions, if their skins have been broken through by ramming or torpedo-explosions. A further claim on behalf of the jet-propeller for war-ships is based upon the less risk of disablement in action, as compared with screws or paddle-wheels; and this claim may be admitted. On the other side must be set the fact that all the trials made hitherto in vessels fitted on the Ruthven system have shown a less speed for a given amount of engine-power than would have been obtained with the screw-propeller. It may be urged, of course, that the decrease in speed should be accepted, at least in special cases, in order to secure the undoubted benefit of the hydraulic system. But the general feeling of naval architects and marine engineers is in favour of the use of twin-screws rather than water-jets for war-ships, the duplication of machinery and propellers decreasing the risk of disablement, giving great manœuvring power, and securing higher speed than could be obtained with the jet propeller.

Recently further trials have been made with a vessel built in Germany, from the designs of Dr. Fleischer, who claims to have devised a novel and more efficient system of hydraulic propulsion. A brief notice of the invention appeared in NATURE, vol. xxvi., p. 18; fuller details are to be found in two pamphlets published by the inventor: "Der Hydromotor," and "Die Physik des Hydromotors" (Kiel, 1881). The first of these pamphlets contains a general description of the system, as applied in the *Hydromotor* (a vessel of 110 feet in length, and about 100 tons displacement), a summary of her trials, compared with those of earlier vessels engined on Ruthven's system, and an enumeration of the advantages to be obtained by using jet-propellers instead of screws or paddles. The second pamphlet contains a statement of the experimental and mathematical investigations conducted by Dr. Fleischer in working out his system.

Dr. Fleischer dispenses with a turbine, and allows the steam to act directly upon the water in two large vertical cylinders placed amidships. These two cylinders communicate with the ejecting nozzles which are situated on either side of the keel. In each cylinder there is a "float" or piston of nearly the same diameter as the cylinder, with a closed spherical top; when this float is in its extreme upper position, the cylinder is full of water. Steam is then admitted into the upper part of the cylinder above the float, the latter is pressed down, and the water is expelled through the nozzle-pipe with great velocity. At a certain portion of the stroke, the admission of steam is shut off automatically, the remainder of the stroke being performed during the expansion of the steam, and the velocity of ejection of the water gradually diminishing. At the conclusion of the stroke, the exhaust-valve from the steam space to the condenser is opened, the steam rushes out, forming a partial vacuum above the float, and the water enters, pressing the float up. The entry of the water at this stage is partly through the nozzle, and partly from a separate valve communicating with the water-space of the surface condenser. In order to utilise the vacuum as much as possible, and to increase the effective "head" of water during the down stroke, the cylinders are placed as high as convenient in the vessel. Two cylinders acting alternately were used in the *Hydromotor*, for larger or swifter vessels it is proposed to use a greater number of similar cylinders. As in other jet-propelled vessels valves operated from the deck enable the commanding officer to reverse the direction of outflow of either or both jets, making the vessel move ahead or astern, or turn on her centre. The position of the nozzles in the *Hydromotor* is not so favourable to manœuvring power as in the *Waterwitch*, and the difference in behaviour is likely to be appreciable.

Greater interest attaches to the trials of speed than to those of turning. Unfortunately the records are too meagre to enable a decisive opinion to be formed on the merits of the new system as compared with that of Ruthven. Dr. Fleischer claims that the *Hydromotor* attained a speed of 9 knots with 100 indicated horse-power; but the conditions under which this speed was attained may have differed considerably from those under which measured-mile speed trials are conducted in this country. Any exact comparison of the performances of two steam-ships with either similar or different systems of propulsion, demands as its basis the elimination of all varying conditions, the determination of the true mean speed, and the calculation of the engine-power corresponding to that speed. Dr. Fleischer may have done all this, but it does not clearly appear in his publications whether he has or not. He distinctly claims for his system a very high "efficiency" as compared with that of Ruthven, but it will be shown hereafter that the formula which he uses is not absolutely correct; and what is more important to note is the circumstance that Dr. Fleischer clearly does not possess the experimental data respecting the resistance offered by the water to the motion of the *Hydromotor* when towed at various speeds, which would enable him to express the true efficiency of the propelling apparatus. On this point a few further remarks may be permittted.

Supposing a vessel to be towed at any speed, and her resistance to be ascertained by a dynamometer, the horse-power expended in overcoming that resistance can be calculated, and. in the terminology of the late Mr. Froude, is styled the "effective horse-power." Next let it be supposed that the vessel is driven at the same speed by her own machinery, and that the "indicated horse-power" in the cylinders is ascertained. The ratio of the "effective" to the "indicated" horse-power expresses the true efficiency of the propelling apparatus, excluding from the account, of course, the efficiency of the boilers. Now what has been said above respecting Dr. Fleischer's figures simply amounts to this: he does not appear to have ascertained the effective horse-power of the *Hydromotor*, and consequently cannot express the true efficiency except as an estimate.

The excess of the indicated horse-power over the effective in any steam-ship is to be accounted for by the waste-work of the mechanism, the waste-work of the propellers, and the "augment" of the tow-rope resistance produced by the action of the propellers. In good examples of screw-steamers the effective horse-power at full speed has been found to vary from 40 to 60 per cent. of the indicated power. Dr. Fleischer claims for the *Hydromotor* a corresponding efficiency of about 34 per cent. at full speed; but not, it would seem, with any certainty.

Passing by this comparison with screw-propelled ships, the *Hydromotor* may be compared with the *Waterwitch.* She gains upon the latter obviously in the avoidance of much waste-work in the mechanism In the Ruthven system there is necessarily more waste-work in the engines which drive the turbines, and in the friction of the water in the turbines and passages to the nozzles, than has to be incurred in the Fleischer system. On the other hand, in the latter system, there must be some loss from condensation of steam in the cylinders, and the high mean velocity of ejection must be a disadvantage. The considerable variations in the velocity of ejection at different parts of the stroke must also be a disadvantage, as compared with the uniform velocity of delivery from a turbine. Respecting the condensation it is asserted, as the result of experiment, that the losses are exceedingly small, the cylinders being wood-lined, and a layer of hot water being formed below the float. Experienced engineers were scarcely prepared for this satisfactory result, anticipating that more serious losses would occur from the alternate heating and cooling of the cylinders. Of course, experience in such a matter is the true test; but it is to be observed that the *Hydromotor* appears to have very ample boiler-power in relation to the indicated horse-power assigned to her maximum speed. Losses from condensation cannot be estimated from the statement of indicated horse-power. The indicator diagrams which have been published, show a very good performance.

The varying rate of outflow through the nozzles must be a source of disadvantage in the Fleischer system. For the hydromotor it is stated that the *mean* velocity of outflow was about 66 feet per second when the speed of the vessel was about 15 feet per second. We are not informed what was the maximum velocity of outflow; the minimum velocity is said to have exceeded the speed of the vessel. This varying velocity, of course, carries with it a varying thrust, and the hydromotor in this respect must be less favourable to uniform motion of the ship than the screw or paddle or Ruthven propeller, where the thrust can be kept practically constant. With two cylinders this might be more felt than with four or more cylinders, but in all cases the drawback must exist.

The high mean rate of outflow involved in the Fleischer system is contrary to the generally accepted view as to the condition most favourable to efficiency. For a given speed of ship, neglecting the augment of tow-rope resistance which may be caused by the action of the propeller, there must be a certain thrust developed, which will overcome the resistance of the water to the advance of the ship. This thrust in the jet-propeller is measured by the sternward momentum generated in the jets. No matter how the mechanism may be arranged, what has to be done by it is to impart to water which has entered the ship and acquired her forward velocity, a sternward momentum which shall have a reaction equal and opposite to the fluid resistance. Momentum, it need hardly be explained, involves the consideration both of the weight of the water acted upon and of the velocity imparted to it in each unit of time. Nor is it possible to create this momentum in the water expelled from the nozzles without doing waste-work in overcoming frictional and other resistances. The magnitude of this waste work may vary greatly in different examples, and it is difficult to estimate its value apart from experiment. Hence in theoretical investigations, this waste-work is usually neglected, although in practice it is of great importance.

Leaving out of account for the moment this waste-work, and the possible influence upon the efficiency of the propeller exercised by the disturbance produced in the surrounding water by the passage of the ship, it may be well to explain briefly the accepted theory of the action of jet-propellers. This is done in the following equations:—

Let V = the speed of outflow of the jets from the nozzles in feet per second, v = the speed of advance of the ship, A = the joint sectional area of the nozzles in square feet, w = weight in lbs. of a cubic foot of water. Then—

Cubic feet of water acted upon per second $= A \,.\, V.$

Sternward velocity of jets in relation to still water $\} = V - v.$

Thrust, or momentum created per second $\} = \frac{w}{g} \,.\, A \,.\, V \,.\, (V - v),$

where g is the accelerating force of gravity—say 32 feet per second. For sea-water $w = 64$; so that $w \div g = 2$ (nearly) Hence

$$\text{Thrust (in sea-water)} = 2\,A \,.\, V \,.\, (V - v).$$

Under the foregoing assumptions, we also have

U = Useful work of propeller (in unit of time) $\}$ = work done in propelling ship.
= Thrust × speed of ship.
$= 2\,A\,V\,(V - v) \,.\, v.$

W = waste work in race $= \frac{1}{2}$ *vis viva.*
$= A\,V \,.\, (V - v)^2.$

$U + W$ = total work of propeller $= 2\,A\,V\,(V - v)\,v$
$+ A\,V\,(V - v)^2$
$= A\,V\,(V^2 - v^2).$

$$\text{Efficiency} = \frac{U}{U + W} = \frac{2\,v}{V + v}.$$

From the last of these equations it is seen that the more nearly the velocity of outflow V approaches the speed of the ship v, the nearer will the efficiency approach its maximum value, or unity. Moreover, for given values of speed of ship and *thrust,* if the difference $(V - v)$ between the speeds of outflow and advance is diminished, the area of the outlets must be correspondingly increased. That is to say, if the value of $V - v$ is diminished, the *quantity of water* $(A \,.\, V)$ operated upon must be increased. Now, in general, it has been supposed that the inferior performance of jet-propelled vessels, as compared with screw steamers was due to the small quantities of water acted upon, In the *Waterwitch,* for example, about 150 cubic feet of water were expelled per second, whereas in the rival twin-screw vessel *Viper* more than 2000 cubic feet of water were operated upon per second. In the *Waterwitch* $V = 30$ feet per second, and $v = 15{\cdot}7$ feet per second; so that according to the foregoing formula

$$\text{Efficiency} = \frac{2 \times 15{\cdot}7}{15{\cdot}7 + 30} = \frac{31{\cdot}4}{45{\cdot}7} = 68{\cdot}7 \text{ per cent.}$$

In the *Hydromotor* $V = 66$ feet (mean velocity) $v = 15{\cdot}2.$

$$\text{Efficiency} = \frac{2 \times 15{\cdot}2}{15{\cdot}2 + 66} = \frac{30{\cdot}4}{81{\cdot}2} = 37{\cdot}4 \text{ per cent.}$$

Dr. Fleischer adopts the foregoing equations, so far as they relate to *thrust* and *useful work*, but for the *total work* he uses another formula, and it is here that we venture to think he goes wrong. According to his investigation—

Total work $= \frac{1}{2}$ *vis viva* of issuing streams.
$= \frac{1}{2} \times$ Mass of water delivered per second × (speed of outflow)².
$= \frac{1}{2} \times 2\,A\,V \times V^2.$

Hence he writes—

$$\text{Efficiency} = \frac{\text{Useful work}}{\text{Total work}} = \frac{2\,A\,V\,(V - v)}{2\,A\,V \times \frac{1}{2}V^2}$$
$$= \frac{2\,V}{v^2}\,(V - v).$$

In thus dealing with the total work, instead of using the expression given above, Dr. Fleischer virtually ignores the fact that the vessel is in motion ahead; and that the streams issuing from the nozzles have the velocity V only relatively to her. It is upon this questionable formula for the efficiency that his estimates above-mentioned are based. For example, in the hydromotor at 9 knots, according to Dr. Fleischer—

$$\text{Efficiency} = \frac{2 \times 15{\cdot}2}{(66)^2}(66 - 15{\cdot}2) = 35{\cdot}4 \text{ per cent.}$$

If the same formula is applied to the *Waterwitch*, at 9·3 knots—

$$\text{Efficiency} = \frac{2 \times 15{\cdot}7}{(30)^2}(30 - 15{\cdot}7) = 49{\cdot}9 \text{ per cent.,}$$

giving about 20 per cent. less efficiency to that vessel, than is given by the accepted formula first stated.

It has been explained that the assumptions upon which the first formula rests are not fairly representative of the conditions of practice. For example, the deduction therefrom (stated above), that it is advantageous to operate upon larger quantities of water, and to reduce the excess in speed of outflow above the speed of the ship requires an important qualification in practice This deduction would be absolutely correct were it not for the waste-work which has to be done in giving the motion to the water; but in actual practice the growth in that waste work may exceed the gain obtained by dealing with larger quantities of water. The parallel case in a screw steamer is that wherein screws of too large diameter or too large surface may involve so much more waste work on frictional or edgewise resistances, that it is preferable to use smaller screws, which operate on smaller quantities of water, but secure a more economical expenditure of power for a given speed, or enable higher speeds to be attained with a given horse-power. In setting aside the commonly received view, and making trial of a system wherein the mean velocity of the outflowing jets is extremely great, while the quantity of water operated on is small, Dr. Fleischer has made an experiment of the greatest interest to all concerned with steam propulsion. If his figures are accepted it is obvious that his system involves much less waste work than the Ruthven system, between the power indicated in the cylinders and the power accounted for in the outflowing jets. On the other hand, as we have endeavoured to explain, this economy of the Fleischer system does not represent the comparative efficiency of the propelling apparatus: because the high and variable velocity of outflow must involve a considerable amount of waste work in the race. A complete comparison could only be made if in the same vessel, or in two vessels of identical form and with identical boiler-power, there were fitted, first, the Fleischer hydromotor; and secondly, the Ruthven arrangement. Then with the same steam-producing power a careful series of trials would settle the matter conclusively. The Swedes did something of this kind in order to compare the efficiencies of twin-screws and water-jets, with the result that the latter were shown to be greatly inferior. Of course it cannot be expected that Dr. Fleischer would undertake such trials unaided; on the other hand, if his system is put forward for adoption in preference to the Ruthven system, it must, at least, be shown to be more efficient, not only in certain intermediate stages in the operations of giving momentum to the jets, but as a whole. This result does not appear to have been attained as yet, so far as can be judged from the published results of trials. The information which is accessible is not complete, and some of the proposed standards of comparison are open to doubt. It is to be hoped, however, that the zeal and ability which have been displayed already by Dr. Fleischer will be still further illustrated in the continued investigation of the capabilities of his novel system of propulsion.

W. H. WHITE

A RAPID-VIEW INSTRUMENT FOR MOMENTARY ATTITUDES

THE wonderful photographs by Muybridge of the horse in motion and those by Maret of the bird on the wing induced me to attempt the construction of apparatus by which the otherwise unassisted eye could verify their results and catch other transient phases of rapid gesture. Its execution has proved unexpectedly easy, and the result is that even the rudest of the instruments I have used is sufficient for the former purpose; it will even show the wheel of a bicycle at full speed as a well-defined and apparently stationary object. This little apparatus may prove to be an important instrument of research in the hands of observers of beasts, birds and insects, and of physicists who investigate such subjects as the behaviour of fluids in motion.

My object was (1) to transmit a brief glimpse of a moving body, (2) to transmit two or more such glimpses separated by very short intervals, and to cause the successive images to appear as simultaneous pictures in separate compartments in the same field of view.

The power of the eye to be impressed by a glimpse of very brief duration has not, I think, been duly recognized. Its sensitivity is vastly superior to that of a so-called "instanteous" photographic plate when exposed in a camera, but it is of a different quality, because the impression induced at each instant of time upon the eye lasts barely for the tenth of a second, whereas that upon a photographic plate is accumulative. There is a continual and rapid leakage of the effect of light upon the eye that wastes the continual supply of stimulus, so that the brightness of the sensorial image at any moment is no more than the sum of a series of infinitesimally short impressions received during the past (say) tenth of a second, of which the most recent is the brightest, the earliest is the faintest, and the intermediate ones have intermediate degrees of strength according to some law, which an apparatus I shall describe gives us means of investigating. After the lapse of one-tenth of a second the capacity of the eye to receive a stronger impression has become saturated, and though the gaze may be indefinitely prolonged the image will become no brighter unless the illumination is increased.

This being premised, let us compare the sensitivity of the eye with that of the rapid plate in the photographic camera under conditions in which the eye is just capable of obtaining a clear view, let us say during an overcast day in a sitting room whose window does not occupy more than one-thirtieth of the total area of wall and ceiling, which is the light under which most of us habitually write and read. A glimpse under these circumstances of one-tenth of a second in duration, suffices, as we have just seen, to give a clear view, but the sensitive photographic plates sold in the shops as "instantaneous" will not give a portrait in that light under thirty seconds exposure. In other words, the sensitivity of the eye is fully 300 times as great as that of the plate. Of course I am aware that more sensitive plates than these have been made, and I have seen a rapidly revolving wheel photographed under the momentary illumination of an electric spark, but I have never heard of that being done when at the same time the revolving wheel was not perfectly distinct to the eye.

The range of ordinary illumination is very great. The photographer who requires thirty seconds in a dim window-light, would photograph clouds in some minute fraction of a second, showing that the illumination of the latter is fully one thousand-fold greater. If then the eye has been shaded and adapted to a dim light, an object in bright sunshine may require no more than the thousandth part of the tenth of a second to be visible, and in saying this, I am confident that I am underestimating what could be done. Consider what even this means: a cannon ball of ten inches diameter in its mid career travels with a velocity of little more than 1,000 feet in a second; in one ten thousandth of a second it would shift its place through only one tenth of its diameter, and would present to the eye, if it could be viewed under the above-mentioned conditions, the appearance of an almost circular disc elongated before and behind by only a slight blur.

It may be said, how is it possible to give such brief exposures as the above? I see no difficulty at all in the matter. Let us take two examples, (1) of quick movement, and (2) of very quick, but by no means the quickest possible, movement. As regards the former, I can flip with my forefinger, and with the greatest ease, a light weight (such as a very small stone) nine feet up in the air; now the maximum velocity of the tip of my forefinger is that of the initial velocity of the stone, which is calculated at once by the usual formula, $v = \sqrt{2fs}$, or taking $2f = 64$, which it is very nearly, $v = 8\sqrt{s}$, the units being in feet and seconds. The velocity in question is therefore 24 feet, or 288 inches per second. As regards a very rapid movement, we may take that of the wing of a bird, which can undoubtedly be rivalled mechanically. A pigeon is by no means the swiftest of birds, but it can fly easily at the rate of 35 miles an hour, and the part of the wing by which it is chiefly propelled and which cannot be its extreme tip, must move much more rapidly than this; let us say, very moderately, at 70 miles an hour, or 1,232 inches per second.

Now the duration of an exposure depends on three data, namely, the rapidity with which the screen moves past the eye, the width of the slit through which the momentary glimpse is obtained, and the diameter of the available portion of the pupil of the eye. I prefer not to limit the pupil by using a small eyehole which is a source of much trouble in actual work, but to have as large an eyehole as is in any way desirable. I find the width of the pupil of my eye in an indoor light as measured by holding a scale beside it and reading off in the looking-glass, to be about 0·1 inch, and I use a slit of the same diameter. The exposure begins when the advancing edge of the slit is in front of the near edge of the pupil, and it ceases when these conditions are reversed, in other words it lasts during the time that the screen is occupied in moving through one fifth of an inch. In the cases just taken of velocities of 288 and 1,232 inches per second, the duration of the exposure would be the 1,440th and the 6,160th part of a second, respectively. There is therefore no difficulty either theoretical or practical about shortness of exposure and sufficiency of illumination. The power exists, and can be utilized, of seeing bodies in motion by a rapid-view instrument, showing them in apparent stillness, and leaving a sharply-defined image on the eye, that can be drawn from visual memory, which in some persons is very accurate and tenacious.

I find on trial that great rapidity of exposure is in nowise essential for analysing the attitudes of a galloping horse or a flying crow. The instrument I commonly carry with me is a very rude one, but convenient for the pocket, and is shewn below. The duration of the exposure given by it under the action of its spring is the 360th part of a second, but the beginning and end of the exposure ought not to count, so little light passing through the edges of the pupil at those times that what is then seen is relatively faint and is disregarded. I estimate its practical duration at about one 500th of a second, and it is rather less when the finger acts with a sharp tap in opposition to the spring. The instrument is shewn in Fig. 1, without its sliding lid, which protects it from injury in the pocket. A is an arm which turns through a small angle round C, its motion being limited by two pins. Its free end carries a vertical screen, R R, which is a cylindrical (or better, a conical sheet described) round an axis passing through C perpendicular to the arm. As the arm travels to and fro, this screen passes closely in front of the end of the box, which is cut into a hollow cylinder (or cone) to correspond. There is a slit in the middle of the screen, and an eyehole in the centre of the end of the box. When the slit passes in front of the eyehole, and the instrument is held as in Fig. 2, a view is obtained. A stud, S, projects upwards from the arm, and an india-rubber band, B, passing round a fixed pin and a descending spoke of the arm acts as a spring in causing the stud S to rise through a hole in the side of the box, where the finger can press it like the stop of a *cornet à piston*. In using the instrument it is held in the hand as in Fig. 2, with the eyehole in front of the eye. Nothing is then visible, but on pressing or tapping the stud the slit passes rapidly in front of the eyehole, and the view is obtained.

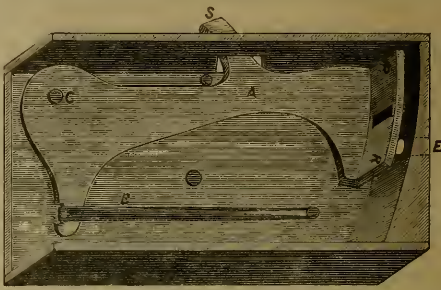


Fig. 1.

After this, the stud is released and the arm springs backwards, when a second view can be obtained, or the eye may be purposely closed for the moment.

I measured the velocity of the instrument by filing a nick on the stud and laying a light weight (a small bent nail) upon it, after having temporarily put in a peg that checked the arm in its recoil when the slit was opposite the eyehole. Then holding the instrument firmly against the wall with the projecting end of the stud as vertical as might be, I drew back the arm and released it, and noted the height to which the weight was tossed. It was three inches. This gave the velocity of the stud in the central portion of the arm, and from this datum the velocity of the more distant screen was easily calculated. I have made more elaborate instruments with multiple levers and with revolving discs (Messrs. Tisley, 172, Brompton Road, are now making one of these for me), but am not as yet prepared to recommend any one of them in particular. Different sorts would be probably be wanted by different persons. For instance it might in some cases be convenient that the trigger should be pulled at the right moment by a bystander, the eye of the observer being in the meantime kept closely shaded from the surrounding light. Again, there are periodic movements which would be best analysed by a slit in a rotating disc whose period of rota-

Fig. 2

tion was a little slower than that of the movement, so that each exposure should show a phase one step in advance of the previous ones; or, again, the rapidity of the periods or that of the motion may be such as to make it necessary to expose only at each second, third, or longer periodic interval. This would be effected by the use of two discs rotating at different velocities. Suppose, for example, one to revolve three times while the other revolved twice, then the two slits would be in accord in front of the eye-hole only once in three revolutions.

In order to present the images formed by two successive glimpses as simultaneous pictures seen side by side in the field of view, I took a prismatic eyeglass of the sort sold by spectacle-makers to correct want of parallelism in the optical axes. I cut it in two pieces, and placed these in opposite ways in front of two horizonal slits, lying one above the other in a shutter that fell vertically between slides. When the first slit came in front of the eye, the image it transmitted was deflected four degrees to the left; and when the second slit followed it, its image was deflected four degrees to the right, and two apparently simultaneous pictures were produced. Also, by crossing the prisms I found it would be easy to construct an apparatus with four successive slits shewing four images; 1, up to the left, 2, up to the right; 3, down to the left, and 4, down to the right. I doubt, however, whether this would be often found a useful development of the instrument, owing to the difficulty of watching more than a small area with attention.

I noticed an important optical effect, namely that the image first seen was always considerably fainter than the others, showing that its brightness had faded in the brief interval that elapsed before comparison began. It would appear that the law of the rate of fading could be investigated by this apparatus. I have not now the opportunity of doing so myself, but if I had, I should mount two prisms below radial slits in a disc that was revolving steadily at a known velocity, and I should watch a circular wafer through them. The width of the slits would be adjustable, and so would the angular distance of the prisms, and I should measure under various circumstances the width of the second slit that was necessary to tone down its image to an equal brightness with that seen through the first. Or the investigation might be made without prisms, by using two wafers and watching them with the same eye through slits at different radial distances, separated by various angular intervals, the adjustments being such that only the outside wafer should be seen through the outer slit, and the inside wafer through the inner one.

FRANCIS GALTON

THE CHEMISTRY OF THE PLANTÉ AND FAURE CELL

PART III.—*The Discharge of the Cell*

THE two plates of a Planté or Faure battery consist essentially of lead peroxide as the negative element, and metallic lead in a spongy condition as the positive. These are brought into communication with one another through the lead plates which support them, together with the connecting wire.

The lead peroxide reacts both with the lead plate that supports it, and with the lead on the opposite plate. At first sight, it might be expected that the reaction between it and the supporting plate would be the greater, as the space between them is so small, and the resistance of the intervening liquid in consequence almost inappreciable. The action is, indeed, probably greater at the first moment, but, as explained in our first paper, sulphate of lead is immediately produced, and that which lies at or near the points of junction, forms no doubt a serious obstacle to further local action, and admits of the lead on the opposite plate coming more fully into play.

If we consider *a priori* what is likely to be the reaction between lead peroxide and lead, with water as the connecting fluid, we should expect:—

$$PbO_2 \mid H_2O \mid H_2O \mid Pb = PbO \mid H_2O \mid PbH_2O_2.$$

On experiment this is found to be actually the case, yellow oxide appearing on the negative plate, and white hydrate on the positive.

If, however, the reaction takes place in presence of dilute sulphuric acid, the result will inevitably be sulphate on both sides, for even if oxide be first formed, it will be attacked by that acid. Of course this production of lead sulphate on each side might be expected gradually to produce a perfect electrical equilibrium. This, in fact, does take place under certain circumstances, but not under others. The reaction on the negative plate is always of this character, as far as our analyses have shown. We have invaribly found the deposit to consist of sulphate of lead mixed with unaltered peroxide. If, however, the cell be allowed to discharge itself rapidly, the lead on the positive plate is converted, not only into the sulphate, but, very partially, into lead peroxide. This is sometimes evident to the eye from the puce colour of the superficial layer, and we found also that this was confirmed by several chemical tests.

It is difficult to conceive how the reduction of the peroxide of lead on the one plate to oxide or sulphate, should be attended by a direct oxidation of lead on the other plate up to peroxide itself, as that would involve a reversal of the electromotive force. It is more easy to imagine that the peroxide results from the oxidation of sulphate of lead already formed, through the agency of electrolytic oxygen.

When this peroxide is formed on the positive plate, it is not difficult to foresee what must happen. A state of electrical equilibrium will be approached before the peroxide of lead on the negative plate is exhausted. But the two sides are in very different positions with regard to local action. On the negative plate, the peroxide being mixed with a great deal of lead sulphate, it will suffer decomposition only very slowly through the agency of the supporting plate, but the lead peroxide on the positive plate, being mixed not only with lead sulphate, but with spongy metallic lead, will be itself speedily reduced to sulphate. Hence, on breaking the circuit, when local action alone can take place, the peroxide formed on the positive plate during the discharges will be destroyed much more easily than the original peroxide on the other plate. The difference of potential between the plates will be restored, and on connection the cell will be again found in an active condition.

Now it has been frequently observed that partially discharged accumulators do give an increased current after repose, that is, after the circuit has been broken and re-established. It remained for us to ascertain whether the chemical change above described coincided in any way with the physical phenomena. For this purpose we prepared plates according to the method of Faure, and examined carefully the changes of electromotive force and strength of current, which took place during their discharge under known resistances, and the chemical changes that took place under the same circumstances.

We found that the initial electromotive force of freshly prepared cells was 2·25, 2·25, 2·21, and 2·31 volts, averaging 2·25, but that after standing for thirty minutes or so, or when allowed to discharge for a few minutes, it was reduced to about 2·0 volts. We take this to represent the normal electromotive force of the arrangement of lead, lead peroxide, and dilute sulphuric acid, and believe that the higher figure obtained at the first moment is due to the hydrogen and oxygen occluded on the respective plates, and which either diffuse out or are speedily destroyed.

We found, however, that in the discharge the electromotive force diminished under certain conditions. Thus, in an experiment in which the external resistance was 1 ohm, and the internal 0·58 ohm, the E.M.F. sank in forty-five minutes from 2·25 to 1·92, but after being disconnected for thirty minutes, it was found to have risen to 1·96, and after eighteen hours' repose it had actually risen to 1·98 volts. These observations were made many times in succession during the course of the experiment, which lasted six days.

With twenty times the external resistance, the diminution of electromotive force was much slower; but after discharging three days, the fall was more pronounced, and the rise on repose very apparent.

With 100 ohms resistance, the electromotive force varied very little for three days.

It is more difficult to obtain satisfactory chemical evidence of a quantitative character. It is clear that as chemical examination means the destruction of the substances, the same plate cannot be analysed in two consecutive stages. Nor can two plates be easily compared with one another, although they have been formed under the same circumstances. Even the same positive plate, during or after discharge, presents to the eye very different appearances in different parts. To a certain extent we obviated this difficulty by cutting the plate in two, longitudinally, analysing the one half at once, and allowing the other to repose for a given time before examining it for peroxide of lead.

As to the estimation of peroxide in the presence of metallic lead, we finally adopted as the best method that of reducing it by means of oxalic acid, although we were not certain that the whole amount is obtained in this way, even though the solution be kept hot for a considerable time.

By this method many chemical examinations were made of the positive plate. The results are as follows:—First of all, when the external resistance did not exceed 20 ohms, the peroxide of lead was generally visible in patches, and its presence was demonstrated and approximately measured by various chemical tests. On repose, the quantity of this peroxide visibly diminished, and in the majority of instances the chemical analyses also showed a smaller amount. In all cases sulphate of lead makes its appearance early in the action, and gradually increases in quantity, becoming finally the only product of the discharge.

The deposit on the negative plate shows the presence of nothing but sulphate of lead in addition to the unchanged peroxide. At the conclusion of the action, we have always found more or less of this substance unaltered. Thus, as one instance, after a discharge lasting five days, and approximately complete, we found that only 68 per cent. of the deposit was lead sulphate.

We conclude therefore that the chemical action of the discharge is essentially what is expressed by the following theoretical formula:—

$$PbO_2 \mid H_2SO_4 \mid H_2SO_4 \mid Pb = PbO \mid H_2O \mid H_2SO_4 \mid PbSO_4,$$

which becomes

$$PbSO_4 \mid H_2O \mid H_2O \mid PbSO_4.$$

This reaction is, however, sometimes complicated by the formation of a small amount of peroxide of lead on the positive plate. We believe this to be due to the oxidation of sulphate, an action which was explained in our last paper.

Another conclusion has reference to the resuscitation of power observed on repose. This is not due to any purely physical action but is a necessary consequence of the formation of PbO_2 on the positive plate. As sooner or later the result of the action becomes solely $PbSO_4$, this temporary formation of peroxide does not seriously affect the quantity of electrical force that may be regained from the accumulator, but it does affect the evenness of its flow. The flow is more regular if the discharge be made slowly, but in that case the loss on the negative plate from local action will probably be greater.

As to practical conclusions, we may note—1. Although, as stated in our paper of March 9, the most economical arrangement for the initial charging of the cell is to "make the red lead to be hydrogenated much smaller in amount than that to be oxidated," yet, as foreshadowed in the same paper, this arrangement is not desirable for the discharge of the cell. Nor is it for its subsequent charging, since, as will have been seen, the substances to be acted upon are now very different. On the negative plate there will be the sulphate of lead produced by the discharge, plus sulphate of lead produced by local action, together with more or less unaltered peroxide. On the positive plate there will be the sulphate of lead produced by the discharge, together with excess of lead, if any. Unless, therefore, the peroxide of lead unacted upon is allowed to be very considerable, the quantity of lead compound on the two sides ought to approach equality. 2. Care should be taken that sulphuric acid is in sufficient excess to allow of there still remaining some of it in solution after all the available lead has been converted into sulphate. If it is removed and only water is present, an oxide or hydrate will be produced with probably some serious consequences to the cell.

J. H. Gladstone
July 3 Alfred Tribe

ON THE DEVELOPMENT OF THE CROCODILIAN SKULL

THE most striking thing in the development of the Crocodile is the structure of its visceral arches, and especially those that form the jaws and the hyoid or lingual arch.

(*a*) *Endoskeletal Parts of the Upper Jaw.*—Inside the massive outer bones of the upper face, or maxillaries and jugals, there are the more delicate palatines, transpalatines, and pterygoids. These are formed in a membranous tract of the palate, and but little cartilage, such as is seen in fishes, makes its appearance.

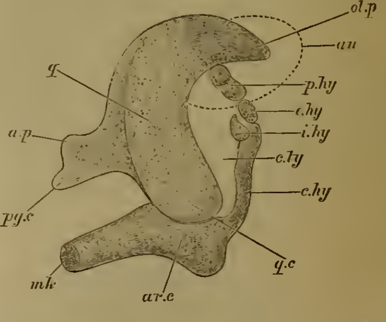


Fig. 1. × 13.

Fig. 1.—Upper part of mandibular and hyoid arches, outer view of second stage (*Alligator missisipensis*), 1½ inch long. *a u*, auditory capsule (in outline); *q*, quadrate cartilage; *ot.p*, its otic process; *a.p*, ascending process; *pg.c*, pterygoid cartilage; *q c*, condyle of quadrate; *mk*, Meckel's cartilage; *ar.c*, condyle of articular region of mandible; *p.hy*, pharyngo-hyal; *e.hy*, epi-hyal; *i.hy*, inter-hyal; *c.hy*, cerato-hyal.

The pterygoids assist the palatines and maxillaries in forming the "hard palate" or secondary floor to the nasal passages, just as in the Ant-bear, Tamandua, and some Cetacea amongst the Mammalia. This hard palate is not seen in Snakes, Lizards, and the smaller Tortoises, but is developed in some degree in the large Turtles. It is but little developed in Birds; for in them only a few such as the Hornbill and *Podargus* have the palatines meeting at the middle below.

The *quadrate* is very huge in the Crocodilia, and is *fixed* as in the Turtle and its congeners, and as in them it forms the greater part of the tympanic cavity; in Snakes, Lizards, and Birds the quadrate, or pier of the lower jaw, is movable.

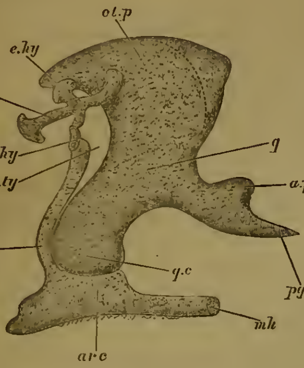


FIG. 2.

FIG. 2.—Upper part of mandibular and hyoid arches of third stage (*Crocodilus palustris*) outer view, 1⅝ inch long. Letters as in Fig. 2, except *co*, columella.

In Salamanders the quadrate cartilage grows up to the top of the skull, in front of the ear-capsule; this part is called the "ascending process; the other fork runs inwards under the fifth nerve, and is either articulated to or fuses with the basis cranii.

In all lizards except the Chameleons such an ascending process is found, but it is segmented off from the quadrate and becomes ossified as the "columella," which supports the roof (this is not the auditory columella, or stapes); I call the former the "epipterygoid." In the Crocodile there appears, very early, a forked process to the quadrate; here the upper fork is the rudiment of the ascending process or "columella," and the horizontal fork is a rudiment of the pterygoid cartilage, which is so large in Sharks and Skates, and forms their upper jaw.

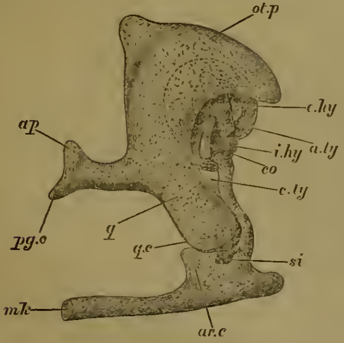


FIG. 3.

FIG. 3.—Same part of same species (fourth stage), 3½ inches long, as Fig. 2 (inner view); *a.ty*, cartilaginous annulus tympanicus.

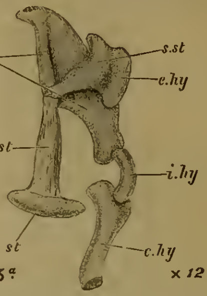


FIG. 3a.

FIG. 3*a*.—Part of same object as Fig. 3 (inner view). Letters same as last, with addition of *st*, stapedial plate; *m.st*, medio-stapedial; *e.st*, extra-stapedial; *s.st*, supra-stapedial.

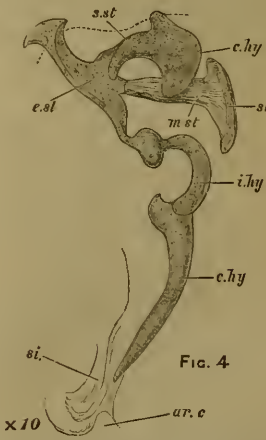


FIG. 4

FIG. 4.—Same species as last (fifth stage, 4½ inches long), outer view. Lettering the same, with addition of *si*, siphonium.

The lower jaw of the Crocodilia corresponds with that of the other Sauropsida—the other Reptiles and Birds, being composed of six splint bones, and an ossification of the articular end of the cartilage, "articulare internum," which unites with the nearest splint, "articulare externum," to form one bone, this, however, is pneumatic, the cartilage itself being hollowed out and communicating by a tube with the cavity of the ear-drum. That tube is called the "siphonium," and Prof. Huxley (see *Proc. Zool. Soc.*, May 27, 1869, p. 391) thought that Prof. Peters had mistaken this tube for a rod of cartilage, which the latter described ("Monatsber. König. Akad. der Wissenschaft. zu Berlin," November, 1868, p. 592) as running directly from the auditory columella into Meckel's cartilage. Such a continuity of the auditory columella (*stapes* and *incus* in one) with the hyoid arch and the endoskeletal lower jaw does, however, exist from an early period, up to the middle of incubation. Prof. Peters' observations were made upon small embryos, Prof. Huxley's upon ripe young; the former observed rightly, but his reasoning upon the facts seems to me to be quite at fault; Prof. Huxley had not the proper materials to work upon, but his reasoning was perfect, and the truth of his deductions, in spite of his mistake about the temporary continuity of the mandibular and hyoid arches, appears to me to be absolutely incontrovertible.

As far as I have seen, there is no other type in which the hyoid "cornu" is chondrified continuously with Meckel's cartilage, or the endoskeletal lower jaw.

This may be an acquired peculiarity, but I rather incline to the view that it is an old *hereditary* characteristic, derived from a very remote ancestry, in which the visceral arches formed a basketwork of cartilage, and not a series of properly segmented arches, such as we are familiar with in most fishes. In *some fishes*, the "marsipobranchii"—Hag and Lamprey—we still see this lower, non-differentiated state of things.

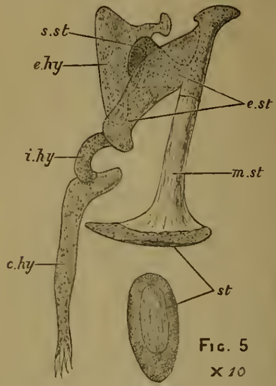


Fig. 5

Fig. 5.—Same species as last (same stage, more advanced, 5 inches long), outer view. Lettering the same; the internal face of the stapes, *st*, is shown.

There is a small distal part to the lingual or hyoid arch, but the lower part of the "cornu" (cerato-hyal) is aborted by the continuity of its upper half with the lower jaw.

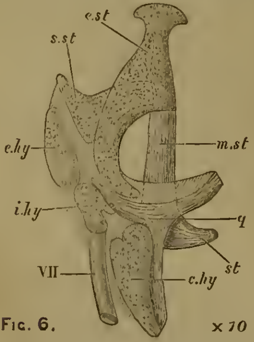


Fig. 6.

Fig. 6.—Same species as last (seventh stage, ripe embryo, 10 inches long), outer view. Lettering the same, with addition of *q*, quadrate bone; VII., facial nerve.

The rest of the arch resembles the branchial arch of a fish, and is like the proper hyoid arch of a Chimæra; the segments correspond very closely, but there is one piece too many, but this intercalary piece—the "inter-hyal"—is found in ganoid and osseous fishes—uniting their hyomandibular with their epihyal.

This fish-like hyoid soon becomes a continuous bar, as in the New Zealand Lizard (*Hatteria*), where the auditory columella and the hyoid arch are one continuous structure.

That condition, however, in the Crocodile, is only continued through the middle part of the term of incubation; towards the latter part of the time the parts that were fused all come to pieces again, and the ripe young has a free columella, with small, distinct nuclei of cartilage attached to the hinder margin of the ear-drum, these are *remnants* of the *epi-*, *inter-*, and *cerato-hyals*—the latter become free from the lower jaw during the middle of the incubating period.

The complex triple Eustachian tubes are formed after the middle of incubation, but before that time the basis cranii had become hollowed out, and so also had the quadrate and the articular end of the mandible.

By the time of hatching there are in the complex tympanic labyrinth or diverticula of the 1st *visceral* cleft, the following parts, namely:—

a. The drum-cavity hollowed out of the quadratum.

b. The middle, single, and the lateral, forked Eustachian tubes.

c. The extension of the tympanic cavity into the whole posterior sphenoid, base and wings, into the periotic bones, and into the whole circle of the occipital arch or ring.

d. Through the "siphonium," into the articular region of the lower jaw.

The investing bones are solid; only the ossifications of the primary chondrocranium are pneumatic; this hollowing out begins to take place before ossification sets in.

The pneumaticity of the Crocodile's endocranium is similar to what obtains in birds, the whole tympanic labyrinth in the two types is singularly like, and singularly unlike.

Note.—For descriptions of these parts in the bird-class I must refer the reader to my papers in the Royal, Linnean, and Zoological Societies. A full account of the development of the skull of the Crocodilia will soon appear in the *Transactions* of the latter society.

W. K. Parker

PROF. HAECKEL IN CEYLON AND INDIA

I.

PROF. ERNST HAECKEL of Jena, as most of the readers of NATURE are doubtless aware, has lately returned to his University after a six months' journey in India and Ceylon, undertaken in the interests of science with the object of providing additional data in support of the theory of evolution, of which he is the most able and best-known exponent in Germany. The veneration which he constantly expresses for Mr. Darwin, of whom he may be said to have been the first and perhaps the chief disciple on the Continent, would of itself suffice to give his opinions and observations weight in this country. No one, however, who has read the series of letters now being contributed by Prof. Haeckel to the *Deutsche Rundschau*, can fail to find them on their own merits both delightful and instructive. They are written in a popular form, but contain traces of profound scientific knowledge combined with great quickness and freshness of observation, and an almost boyish exuberance of delight in the presence of nature's wonders. Of the three letters or articles already published, the first contains an account of the voyage to India, the second, entitled "A Week in Bombay," describes with vivid enthusiasm the caves of Elephanta and the other marvels of that most interesting of tropical cities, and the third, contained in the June number of the *Rundschau*, of which we propose to give a short reproduction for the benefit of our English readers, brings the Professor to the "promised land" of his scientific yearnings—that island of Ceylon which exhibits in all its varied charms "the highest conceivable development of Indian nature."

It was on November 21, 1881, that the Austrian Lloyd steamer *Helios*, bearing Prof. Haeckel and his numerous chests, some containing scientific instruments, others empty for the reception of specimens, came to an anchor in the harbour of Colombo. He describes in a few graphic words the vision of beauty which met his eager gaze as the morning twilight cleared away, and the island, with its fringe of delicate palm forests, and more thickly wooded interior highlands, crowned in the centre by the mysterious summit of Adam's Peak, expanded before him in all the blaze of tropical sunshine. Directly in front lay the fort and harbour, to the right (or south) the beautiful suburb of Colpetty, in which the majority of the Europeans have their residence, and to the left (or north), the Pettah or "Black town," inhabited by the native races. Prof. Haeckel was warmly received on landing by his countryman, Herr Stipperger, the agent of the Austrian Lloyd, in whose bungalow, on the northern side of the town, at a considerable distance from the fort, and still farther from Colpetty, he passed the two first weeks of his stay in Colombo, which he describes as among the most delightful of his life. His first drive in Ceylon, from the Fort to Whist Bungalow, through the Pettah, opened out before him. as he himself says, a quick succession of scenes of Eastern beauty. The brown clay huts of the natives, each with its garden of cocoa-nut palms and plantains; the motley population of red-brown Singhalese, and darker Tamils, grouped round the doors, carrying on all their domestic concerns in the open air, combined with the bright red tint of the soil to produce bewildering contrasts of form and colour, together with a charming impression of primitive simplicity, and harmony with surrounding nature. It would be impossible to make even a passing mention of the Singhalese and their domestic life without digressing into a description of their most valued and often their only possession, the cocoa nut palm of whose substance every part is turned by them into account.

"The number of cocoa palms on the island," says Prof. Haeckel, "is calculated at 40,000,000, each palm yielding from 80 to 100 nuts (8-10 quarts of oil). It is not found in the northern half of the island, nor on a great part of the eastern coast. Its place is here supplied by the not less useful palmyra palm (*Borassus flabelliformis*). This is the same which covers the hot and dry districts of Hindostan, growing in great profusion near Bombay. Even from a distance the two palms vary greatly. The palmyra is a fan-palm, with a strong, very straight black stem, topped by a thick bunch of fan-shaped leaves. The cocoa, on the other hand, is a feather-palm, its slender white stem, 60 to 80 feet high, is gracefully curved, and adorned with a bushy crown of feathery leaves. The lovely Areca palm (*Areca catechu*) has similar, but stiffer and smaller leaves, and a tapering reed-like stem; it is an invariable feature of a Singhalese garden, carefully tended for the sake of the nut, which, being chewed together with the leaf of the betel pepper, colours the teeth and saliva red. Another palm, the Kitool (*Caryota urens*) is cultivated chiefly on account of its abundant sugar-sap, from which palm-sugar (*Djaggeri*) and palm wine (*Toddy*) are prepared. Its stiff strong stem supports a crown of double-feathered leaves resembling those of the maiden-hair fern (*Adiantum capillus Veneris*)."

"After the palms the most important trees in the little gardens of the Singhalese are the bread-fruit and the mango. Of the former there are two kinds, the ordinary bread-fruit (*Artocarpus incisa*), and the Jak tree (*Artocarpus integrifolia*), growing everywhere in great profusion. Another tree frequently cultivated by the natives is the curious cotton tree (*Bombax*). Mingled with these round the Singhalese huts is the beautiful banana or pisang tree, well deserving the name of "fig of Paradise" (*Musa sapientum*). Its beautiful yellow fruit, affording excellent nourishment either raw or cooked, is here seen in numerous varieties. Magnificent clusters of its gigantic light green leaves topping a slender stem from 20 to 30 feet high overhang the Singhalese huts, and form their loveliest adornment. Scarcely less effective are the arrowy leaves of the Aroideæ, especially of the Caladium, cultivated for its esculent roots, the same being the case with the Manihot, with its lovely clusters of hand-shaped leaves (belonging to the Euphorbiaceæ)."

Prof. Haeckel next proceeds to give a short statistical account of the population of Ceylon. In Columbo itself, as well as in the whole southern and western crests of the island (with the exception of the north-west) the large majority of the population consists of Singhalese proper, or descendants of the Indian Hindoos who overran Ceylon in the sixth century B.C., but in the northern half of the island, and on the east coast, as well as in large tracts of the central highlands, the Singhalese have been driven out by the Malabars or Tamils from the southern parts of the Indian peninsula, more especially from the Malabar coast. At present the Tamils comprise about a third of the whole population of Ceylon, and their number is yearly increasing; they are stronger and hardier than the Singhalese, and all the heavier labour falls to their share, the Singhalese only occupying themselves in the lighter kinds of agricultural work. Besides these, there are the Indo-Arabians of Ceylon (called Moormen or Moors), descendants of the Arabs who gained a footing in the island more than two centuries ago. The residue of the native population is composed of the wild aborigines (Veddahs and Rodiyahs) of immigrant tribes from various parts of Asia and Africa, and of Malays, Javanese, Parsees, Afghans, Negroes, and Kaffirs; in all about 25,000. Europeans number altogether only three to four thousand, principally, of course, English and Scotch. The whole of this motley population at the present time may be calculated at 2,500,000, divided as follows:—

Singhalese (chiefly Buddhists)	1,500,000
Tamils (or Malabars, chiefly Hindoos)	820,000
Indo-Arabians (Moors, chiefly Mohamedans) ...	150,000
Mixed descendants of various races	10,000
Asiatics and Africans (Malays, Chinese, Kaffirs, Negroes, &c.)	8,000
Burghers (Portuguese and Dutch half-bloods) ...	6,000
Europeans (chiefly English)	4,000
Veddahs (aborigines)	2,000
Total	2,500,000

A considerable number of all the native races have been converted to Christianity.

Whist Bungalow, where, as we have already mentioned, Prof. Haeckel spent the earlier part of his stay in Ceylon, received its somewhat curious name from the passionate addiction to card-playing of a former possessor. It is situated on one of the most picturesque spots in the neighbourhood of Colombo—that which lies to the north of the fort on the angle between it and the mouth of the river Kalany. Some portions of the description of the site of the bungalow and of his friend's garden must be given in Prof. Haeckel's own words:—

"The airy verandah commands a magnificent view of the sea, of the mouth of the Kalany, and of a lovely little island covered with vegetation, which lies in its delta. Further north, the eye follows a long strip of cocoa wood extending along the coast to Negombo. To the south lies the garden of the Bungalow, and beyond it a picturesque plot of land scattered over with fishing huts, nestling under the shade of slender palms; in their midst a little Buddhist temple, and further on a rocky swamp

---

[1] Sir J. Emerson Tennent ("Ceylon," I., p, 127), mentions, as curiously illustrative of the minute subdivision of property in Ceylon, a case which was decided in the district court of Galle, the subject in dispute being a claim to the 2520th *part of ten cocoa nut trees!*

covered with screw pine (*Pandanus*), &c. From this swamp springs a narrow sandy neck of land extending northward to the river's mouth, and so lying as to inclose a peaceful little lake in front of our garden. A few fishing huts are erected on this tongue of land, and from morning to night it presents a constant succession of animated and amusing pictures. Here in the early morning, before sunrise, the inhabitants of the huts assemble to take their morning bath in the river. Then the horses and oxen have their turn, and are brought down to water. Busy washers are at their work all day, beating the clothes with flat stones, and spreading them on the shore to dry. Fishing boats go up and down continually; and in the evening, when they have been drawn up to land, and the great square sails have been spread to dry, the lagoon, with its long row of motionless sails, looks wonderfully picturesque, especially when the evening breeze swells the sails, and the sun, sinking into the sea, floods the whole shore with a radiance of gold, orange, and purple. . . . . The garden of Whist Bungalow has been converted, by the care and taste of its proprietor, into a veritable earthly paradise, containing examples of almost every native plant of importance, and thus forming a valuable botanical collection, as well as a fragrant and delightful pleasure garden. On the very first morning of my stay, as I wandered in rapturous delight under the shade of palms and fig trees, bananas and acacias, I gained a very comprehensive idea of the flora of the plains. Here the noble palm, in all its variety of foliage and fruit, rears its stately columns; cocoa and talipat, areca and borassus, caryota and palmyra; here the banana spreads its great feathery leaves to the wind, and displays its clusters of precious golden fruit. As well as various kinds of the common banana (*Musa sapientum*), a fine example of the Traveller's tree of Madagascar may here be seen (*Urania speciosa*). It stands just at the division of the principal walk, from which the path to the right leads to the bungalow, and that to the left brings us to a magnificent specimen of the banyan or sacred fig tree (*Ficus bengalensis*), forming, with its hanging air-roots and numerous stems, a very striking object; beautiful Gothic arches open out among the roots which, pillar-wise, support the main structure of the tree. Other trees of various groups (terminalia, laurels, myrtles, ironwood trees, bread-fruit, &c.) are over-grown and intertwined with those lovely creeping and climbing plants which play so important a part in the flora of Ceylon. These belong to the most varied families, for in the dense forests of this magic island, and under the favourable influences of moisture and warmth, a countless multitude of climbing plants strive and cling, and grasp their way upward to the light and air.

"Among the charms of this most lovely garden must be included the large-leaved Calla plants or Aroideæ, and the graceful feathery ferns, two groups of plants, which, both by their individual mass and by the beauty and size of their development, occupy an important place in the lower flora of Ceylon. Scattered among them are many of the finest shrubs and flowering plants of the tropics, partly indigenous, partly introduced from other tropical regions, especially from South America, but all perfectly at home here. Among these rises the stately Hibiscus, with great yellow or red flowers, the flame tree or acacia, a mass of splendid flame-coloured clusters (*Cœsalpinia*); venerable tamarinds with their aromatic blossoms; while from every branch hang clinging convolvuli with gigantic bell-shaped flowers, and aristolochias, yellow and brown. Rubiaceous plants, such as lilies, orchids, &c., bear extraordinarily large and beautiful blossoms. . . . The animal life inhabiting this garden of Eden does not altogether correspond in variety and abundance with its vegetable world; this is especially the case with its larger and more striking forms. In this respect, as far as I have been able to ascertain, the island is inferior to the Indian mainland and to Sunda Island, and still more so to tropical Africa and Brazil. I must confess that my first impression was one of disappointment, which rather increased than diminished as I came to know the fauna more intimately, even in the wilder parts of the island. I had expected to find the trees and bushes thronged with apes and parrots, and the flowering plants with butterflies and winged insects of curious form and brilliant hue. But my expectations were doomed to remain unfulfilled, and my only consolation was that other zoologists visiting the island had been equally disappointed. Nevertheless, careful search reveals much that is curious and interesting, even to the zoologist, and in its main features the fauna of Ceylon, though not so rich and brilliant, is quite as singular and characteristic as its flora.

"The vertebrate animals which first claimed my attention in Whist Bungalow and the immediate neighbourhood of Colombo, were numerous reptiles of brilliant colours and curious forms, especially snakes and grasshoppers, and pretty little tree frogs (*Ixalus*), whose weird, bell-like note, resounded in the evenings. The birds chiefly visiting the gardens are starlings and crows, water-wagtails and bee-catchers, and above all the pretty little honey-sucker (*Nectarinia*), which here takes the place of the humming-bird; kingfishers and herons abound on the river banks. Among mammalia the most frequently occurring is the pretty little squirrel that leaps about among the trees and shrubs, and is very tame and confiding; its colour is a brown grey, with three white stripes lengthwise down its back (*Sciurus tristriatus*). Among the insects, dense swarms of which abound everywhere, the first to be named are ants (from the minutest to the most gigantic sizes) including the destructive termites or white ant; wasps and bees among the hymenoptera, and gnats and flies among the diptera are also very abundant. The larger and finer forms of insect life, such as chafers, butterflies, &c., do not exist in any proportion to the flora of the island. Orthoptera (grasshoppers, crickets, &c.), on the other hand, are very varied and curious in form. I will content myself at present with this cursory mention of a subject to which I hope later to return.

"Of articulate animals the spiders (*Arachnidæ*) form a very interesting and curious class, from the minutest mites and ticks upwards to the bird-spinners and scorpions. The closely-allied Millipeds or Myriapodæ are very numerous and of colossal size, sometimes as much as a foot long. I saw one famous specimen on my first morning in the garden of Whist Bungalow, but I was too lost in admiration of the glories of the vegetable kingdom round me to have time for a nearer examination of the animal world."

In this first intoxication of delight which accompanies the realisation of a life-long dream, we must for the present leave Prof. Haeckel, hoping in a future number to give some further account of his observations on the fauna and flora of Ceylon.

NOTES

WE hear that Princeton College, New Jersey, is going to despatch a second scientific expedition this summer to the "bad lands" of Dakotah and Nebraska in search of fossils. It will be under the charge of Mr. W. B. Scott, of the "E. M." Geological Museum of Princeton, who ii known to many readers of NATURE on this side of the Atlantic by his papers on the development of *Petromyzon*, &c. A former expedition of a similar kind, undertaken in 1877 under the same auspices, and composed of Messrs. Scott, H. F. Osborn, and F. Speir, jun., succeeded in making a valuable collection of vertebrate remains, which have been fully described in the "Palæontological Report of the Princeton Scientific Expedition of 1877" (Princeton, 1878), and now adorn the geological museum there.

AN interesting telephonic experiment was made on Tuesday at Malta, during the bombardment of the Forts at Alexandria. A telephone was attached at Malta to the Alexandria cable, and connection was made with the other end of the cable on board the *Chiltern*, off Alexandria. It was found that, owing either to the distance, or to the vibration caused by the firing, it was impracticable to send a verbal message, but the firing at Alexandria was distinctly heard, through the telephone, at Malta—a distance of more than a thousand miles.

A VISIT was paid on Tuesday to the School of Military Engineering and the Royal Engineer establishment at Chatham by the members of the Society of Telegraph Engineers and Electricians. Over 500 of the members, associates, and friends of the society accepted the invitation of the president, Col. Webber, R.E., and were entertained by him at luncheon at the Royal Engineers officers' mess. The guests were shown over the schools, following a programme arranged by the Acting Commandant, and conducted by the officers of the Royal Engineers, who were indefatigable in providing for the entertainment of all. A lecture on torpedo warfare was delivered in the theatre by Major Armstrong, R.E., and the guests visited amongst other sights in the Royal Engineer Institution the schools of electricity, photography, chemistry, architecture, and surveying. Outside, the Engineers' Field Park, the mechanical workshops, the construction of military bridges, use of brushwood for military purposes, siege batteries, earthworks, demolition of railways and stockades, also submarine mine explosions, afforded a most interesting programme, especially so at a moment when all these appliances may be at any moment brought into practical use.

THE Rector of a small parish in Warwickshire is endeavouring to protect and preserve a fine granite boulder, identified as having been floated from Mount Sorrel in Leicestershire, a distance of sixty miles, and now exposed to danger of destruction. To rail it in and record its history by a permanent inscription will cost about 12*l*. The parish is a poor one, and the Rector crippled by an unlet glebe; but 5*l*. has been promised in the village, and 1*l*. has been given by the Boulder Committee of the British Association through its Secretary, Rev. H. W. Crosskey, who has seen the boulder, and will vouch for its scientific interest and value. If any reader of NATURE is good enough to send a small contribution towards the 6*l*. still wanted, to the address of "Rector—care of Editor of NATURE," it will be acknowledged in these columns.

WE regret to announce the sudden death of M. Antoine Breguet, at the early age of thirty years. He was the son of M. Breguet, the member of the Institute, one of the directors of the International Exhibition of Electricity in Paris, and had had for two years the editorship of the *Revue Scientifique*, and the direction of the well-known Breguet optical and horological workshop.

THERE is now at Gresham College, in Basinghall Street, an interesting collection of objects which have been sent over from the Technical School at Iserlohn, in Westphalia. They comprise examples in wax, plaster, wood, and metal, the works executed by students in the special trade-school which was founded by the Prussian Government, and which is said to have rendered important service to the manufactures of the district. The collection has been sent over in response to the application of Mr. Philip Magnus, one of the Royal Commissioners on Technical Education, and inspection will be permitted on application to that gentleman during this week.

BY last advices from Manila (May 17), according to the *London and China Telegraph*, two German naturalists, Messrs. Schadenburg and Koch, had just arrived there from Mindanao, where they had recently successfully ascended a volcano called Apo, the highest mountain in the Philippines, a feat only once before achieved by Europeans, this being in October, 1880. After several vain attempts, Senor Rajal, in 1880, a few months after assuming the governorship of the district, determined to ascend the volcano, notwithstanding the opposition of the Bagobo savages, who assured him that a human sacrifice was essential for success. His influence over them was, however, so great that he prevailed on fifty of the savages to accompany him as guides and porters, and was thus enabled to set out on the expedition in October that year with several Spaniards and Dr. Montano, a French naturalist. The ascent proved so dangerous and difficult that only Dr. Montano and Senor Martinez reached the top on the north-east side of the volcano, its height being determined by them at 3130 metres above the sea. The safe return of this expedition after nine days' absence without the human sacrifice required by the savages resulted in lessening their superstitious dread of the Apo. The *Diario* states that Messrs. Koch and Schadenburg made two ascents of the Apo in February and March last, under the guidance of several savages, during which they ascertained the height of its south-west peak to be 3000 metres (10,824 Eng. feet) above sea level.

IN the July number of the *American Naturalist* is a paper of much value by Mr. Ivan Petroff on the Limit of the Innuit Tribes on the Alaska Coast, in which the writer combats some of the conclusions come to by Mr. Dall. Mr. Petroff has been familiar for years with these coasts, and his conjectures as to the origin and migration of the Innuits and other tribes will interest ethnologists. In this connection Mr. Petroff has some important observations on the rate of accumulation of shell-heaps. He says:—"The time required for the formation of a so-called layer of 'kitchen refuse' found under the sites of Aleutian or Innuit dwellings, I am inclined to think less than indicated by Mr. Dall's calculations. Anybody who has watched a healthy Innuit family in the process of making a meal on the luscious echinus or sea urchin, would naturally imagine that in the course of a month they might pile up a great quantity of spinous *débris*. Both hands are kept busy conveying the sea fruit to the capacious mouth; with a skilful combined action of teeth and tongue, the shell is cracked, the rich contents extracted, and the former falls rattling to the ground in a continuous shower of fragments until the meal is concluded. A family of three or four adults, and perhaps an equal number of children, will leave behind them a shell monument of their voracity a foot or eighteen inches in height after a single meal. In localities in Prince William Sound I had an opportunity to examine the camp-sites of sea-otter hunters on the coast contiguous to their hunting-grounds. Here they live almost exclusively upon echinus, clams, and mussels, which are consumed raw in order to avoid building fires and making smoke, and thereby driving the sensitive sea-otter from the vicinity. The heaps of refuse created under such circumstances during a single season were truly astonishing in size. They will surely mislead the ingenious calculator of the antiquities of shell heaps a thousand years hence."

IN the same article Mr. Petroff has also some interesting observations on the action of tides on the coast:—"As an instance of the rapidity with which the tides of this region will change outlines of coast and other land marks, I may cite an observation made by me during my stay on Nuchek island last summer. At a short distance from the settlement there was a cave in a rocky cliff situated about three or four feet above high water mark. I visited the place frequently, as it afforded a view over the approaches to the harbour. About the middle of June an eclipse of the moon occurred when it was full or nearly so, causing tidal commotion of unusual extent and violence. When I visited my cave on the day following the eclipse, I found it almost filled with shingles and *débris*. This cave was situated at about the same height above the water as the cave of Amaknak, from which Mr. Dall extracted such voluminous information as to the antiquity of strata of refuse found therein. I cite these instances only for the purpose of showing that it is not safe to ascribe great age to any and all accumulations of *débris* found on the coast of Alaska, and also as a support for my theory of a general Innuit migration along the coast at a comparatively recent period, subsequent to the invention of the kaiak or a similar structure."

FROM the Italian Census of December 31, 1881, it appears that in 23 out of 24 provincial chief towns the number of persons knowing how to read and write has greatly increased since 1871. In ten years the citizens of Udine had increased in such knowledge at the rate of 9 per cent.; in Como, 6·50 per cent. Brescia made a strange exception; in 1871 there were 2899 persons ignorant of reading and writing, and in 1881 this number was increased to 3120 persons; data are wanting to explain this fact. In the 24 capitals of provinces the average result is that a little more than 50 per cent. of the inhabitants know how to read and write.

MESSRS. TRÜBNER AND CO. have issued a second and much enlarged edition of their "Catalogue of the Principal Languages and Dialects of the World." The original catalogue contained about 1100 titles on 64 pages, while this edition enumerates nearly 3000 titles on 170 pages. The utility of such a catalogue to students of language is obvious.

WITH praiseworthy promptness Messrs. Blackie and Son have issued the third volume of the new edition of the Imperial Dictionary, edited by Mr. Charles Annandale. This volume extends from L to Screak, and in all respects is up to the two first volumes. The only omission of importance we detect is Photophone, which perhaps came too late to be put in its proper place.

A FRENCH engineer has originated a plan by means of which passing ships could send messages by submarine cables; he would float buoys with the necessary connecting wires and apparatus at intervals of a day's journey along the line of the cable, each numbered and properly lighted at night. The writer in the *Moniteur de la Flotte* considers that the plan presents but few difficulties, and would obviate much anxiety and many dangers.

DR. SCHLIEMANN is carrying on new excavations at Hissarlik, with the assistance of two eminent German architects. No fewer than 150 workmen are daily employed in laying bare the foundations of the ancient cities. Two perfectly distinct cities have lately been discovered in the burnt stratum, the lower one resting on the large walls which have hitherto by mistake been attributed to the second city. Hissarlik now turns out to have been the Acropolis of this lower burnt city, this being proved by the walls and the pottery, as well as by two vast brick buildings, one of them 43 feet broad by 100 feet long, the other 23 feet broad by less than 100 feet long. These buildings seem to have been temples, a separate gateway, flanked by enormous towers, leading up to them. There are, besides, three or four large buildings, apparently dwelling-houses, but no smaller buildings. The city walls now stand out very imposing. They rest on a substructure of large blocks, 33 feet high, afterwards superseded by great brick walls. All the treasures formerly found by Dr. Schliemann are now ascribed to the first burnt city. Dr. Schliemann has found in the temples copper nails of a very peculiar shape, weighing from 1000 to 1190 grammes. The second burnt city, being the third city from the rock, and hitherto identified with the Homeric Troy, turns out to have had but very small houses and no lower town at all. Dr. Schliemann will continue his excavations till the beginning of August.

SOME interesting objects which have, according to the *Daily News* correspondent, just been found in Neuchatel are considered by Swiss archæologists to throw a new light on the history of the lake-dwellers, and the discovery is consequently looked upon as one of importance. Amongst the objects are a carriage-wheel with iron rim, iron swords, and many human bones.

THE *Field Naturalist* is the name of a new natural history journal, published by A. Heywood of Manchester; it is stated to be "a medium of intercommunication," and for this purpose it will doubtless be of service to the many cultivators of science throughout the country.

THE *Proceedings* of the Liverpool Naturalists' Field Club for 1881-82, gives the usual account of the numerous excursions of this Society; they seem to have been successful. We have also received an interesting brief Report of the work done by the York School Natural History Society during the past year; this Society has founded a special section, exclusively devoted to scientific workers.

THE additions to the Zoological Society's Gardens during the past week include a Red-legged Partridge (*Caccabis rufa*), European, presented by Dr. A. O. Grosvenor; a Ring Ouzel (*Turdus torquatus*), British, presented by Mr. H. A. Macpherson; a Red-sided Eclectus (*Eclectus polychlorus*) from New Guinea, presented by Mr. A. Lubbock; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Master Charles Ed. Napier; a Dwarf Chameleon (*Chamæleo pumilus*), eighteen Rough-scaled Lizards (*Zonurus cordylus*), a Banded Skink (*Euprepes vittatus*), a South African Skink (*Scelotes bipes*), four Beetles (*Scarites rugosus*), four Beetles (*Psorodes*, sp. inc.) from Robben Island, South Africa, presented by the Rev. G. H. R. Fiske, C.M.Z.S.; a Goshawk (*Astur palumbarius*), European, deposited; two Black Leopards (*Felis pardus*), an African Elephant (*Elephas africanus* ♂) from Africa, a Hardwick's Hemigale (*Hemigale hardwicki*) from Borneo, a Cuvier's Lagotis (*Lagotis cuvieri*) from Patagonia, a Pronghorn Antelope (*Antilocapra americana*) from North America, a Malayan Tapir (*Tapirus indicus*), two —— Hornbills (*Buceros*, sp. inc.) from Malacca, purchased; a One-Wattled Cassowary (*Casuarius uniappendiculatus*) from New Guinea, received in exchange; three Chiloe Wigeons (*Mareca chiloensis*), bred in the Gardens.—The following insects have emerged during the week:—Silk Moths: *Actias selene*, *Telea polyphemus*; Butterflies: *Parnassius apollo*, *Vanessa polychlorus*, *Thecla spini*, *Melanagria galathea*; Moths: *Deilephila euphorbiæ*, *Sciapteron tabaniformis*, *Bembecia hylæiformis*, *Zygæna filipendulæ*, *Plusia concha*.

PROF. MENDELEEF ON THE HEAT OF COMBUSTION OF HYDROCARBONS[1]

"IN considering the numerical data as to the heat of combustion," Prof. Mendeleeff says, "it will be perceived that until now sufficient attention has not been given to the distinction between purely calorimetrical data and those physical and mechanical changes which accompany chemical reactions, while it was recognised long ago that it is essential to separate, as far as possible, the heat of the reaction from the heat disengaged by physico-mechanical processes. The drawback arising from this is especially noticeable with regard to the heat of combustion of compounds of carbon, as this heat is used for measuring the heat of formation of compounds of carbon from simple bodies, which last is, as is known, but a small fraction of all the heat of combustion." Thus, for example, when the products of combustion of CO_2 and of H_2O act on incandescent charcoal, both reactions are very similar, if we do not give attention to the physical process which accompanies the second reaction. The

---

[1] "Notice on the Heat of Combustion of Hydrocarbons," in the *Journal of the Russian Chemical and Physical Society*, vol xiv. pp. 230-238.

reaction $CO_2 + C = CO + CO$ shows that out of two volumes of CO_2 we receive four volumes of CO, and it is accompanied with absorption of heat, which is determined by the fact that the combustion of one atomic weight of carbon develops 97 K (*i.e.* 97 great calorics, or 97,000 common ones), while the combustion of CO develops 68·4 K; the reaction is thus accompanied by the following thermal result: $97·0 \text{ K} - 2 \times 68·4 \text{ K} = -39·8 \text{ K}$. The result $(97·0 - 68·4 - 68·4 = -39·8 \text{ K})$ is the same for the following reaction: $H_2O + C = CO + H_2$; and, if the combustion of hydrogen in the calorimeter were not accompanied by a formation of liquid water, it might be admitted that the combustion of CO and of H_2 develops the same amount of heat, which, however, is not the case.

After having shown how the conclusions on the heat of formation of hydrocarbons from hydrogen and coal, or diamond, are vitiated by not taking into account the heat developed, or absorbed, by physical and mechanical processes, and how M. Thomsen (*Berliner Berichte*, 1880, p. 1321) was brought to erroneous conclusions as to the structure of the molecule of coal and diamond, as well as to the structure of hydrocarbons; M. Mendeleef says:—"In using calorimetrical data of chemical reactions to judge of the variation of chemical energy in a reaction, it is necessary to free them from the influence of physical and mechanical processes which accompany the reaction. Of course, the relative influence of these secondary processes is not very great, as the chemical process is the most important one, especially in such energetic reactions as the combustion of hydrocarbons; but it is important, for strictly maintaining the principle itself of thermo-chemistry, always to apply this correction, as we always apply the correction for loss of weight in the air, especially when weighing gases." "Only in the gaseous state can we consider the thermal relations of bodies free from the influence of the modified internal work, as was well pointed out by Berthelot in the first chapters of his work: 'Essai de Mécanique chimique'; therefore, all comparisons must be made in the gaseous state, as well for the bodies entering into reaction, as for those which we receive. When the determination of the heat of combustion is made for solid or liquid bodies, we obviously must add the latent heat of evaporation (and liquefaction) of the body, and deduct the latent heat of evaporation of water. This last is well known, and for a molecular weight in grammes (18 grammes) of water, it is equal to about 10·7 K at the temperature of 15° to 20° Cels. As to the heat of evaporation of hydrocarbons, it is still not sufficiently known. But we know that the heat necessary for the evaporation of *molecular quantities* of different bodies comparatively volatile, varies from 4 K (as for NH_3 and N_2O) to 15 K (as for quicksilver and ethyl), and usually is between 6 K to 10 K." This correction not being very great, and the determinations of heat of combustion not being yet very accurate, Prof. Mendeleef takes, for those bodies whose heat of evaporation is not yet determined, an approximate correction. Another correction is that which results from changes of volume of combining bodies. The mechanical work which results from this increase or decrease of volume is not very great (0·57 K in most of the determinations of Thomsen), but always must be taken into account.

By applying these corrections, Prof. Mendeleef gives a new corrected table of heats of combustion of twenty different hydrocarbons, as well as the heats of formation of these bodies from CH_4, CO, and CO_2. The corrections are not insignificant, as, for instance, for hydrogen, CH^4, C^2H^6, C^3H^5, and C^7H^{16}, whose heats of combustion, as determined by Thomsen, Berthelot, and Loughinin, are respectively—68·4, 213·5, 373·5, 533·5, and 1137·4; the corrected figures, as given by M. Mendeleef, are—57·4, 192, 342, 492, and 1062.

THE WEDGE PHOTOMETER[1]

MUCH attention has recently been directed to the use of a wedge of shade glass as a means of measuring the light of the stars. While it has been maintained by various writers that this device is not a new one, the credit for its introduction as a practical method of stellar photometry seems clearly to belong to Prof. Pritchard, director of the University Observatory, Oxford. Various theoretical objections have been offered to this photometer, and numerous sources of error suggested. Prof. Pritchard has made the best possible reply to these criticisms by measuring a number of stars, and showing that his results agreed very closely with those obtained elsewhere by wholly different methods. His instrument consists of a wedge of shade glass of a neutral tint inserted in the field of the telescope, and movable so that a star may be viewed through the thicker or thinner portions at will. The exact position is indicated by means of a scale. The light of different stars is measured by bringing them in turn to the centre of the field, and moving the wedge from the thin towards the thick end until the star disappears. The exact point of disappearance is then read by the scale. The stars must always be kept in the same part of the field, or the readings will not be comparable. By a long wedge the error from this source will be reduced. A second wedge in the reversed position will render the absorption uniform throughout the field. Instead of keeping the star in the same place by means of clockwork, the edges of the wedge may be placed parallel to the path of the star, when the effect of its motion will be insensible. To obtain the best results, the work should be made purely differential, that is, frequent measures should be made of stars in the vicinity assumed as standards. Otherwise large errors may be committed, due to the varying sensitiveness of the eye, to the effect of moonlight, twilight, &c., and to various other causes.

A still further simplification of this photometer may be effected by substituting the diurnal motion of the earth for the scale as a measure of the position of the star as regards the wedge. It is only necessary to insert in the field a bar parallel to the edge of the wedge, and place it at right angles to the diurnal motion, so that a star in its transit across the field will pass behind the bar, and then undergo a continually increasing absorption as it passes towards the thicker portion of the wedge. It will thus grow fainter and fainter, until it finally disappears. It is now only necessary to measure the interval of time from the passage behind the bar until the star ceases to be visible, to determine the light. Moreover, all stars, whether bright or faint, will pass through the same phases, appearing in turn of the 10, 11, 12, &c., magnitude, until they finally become invisible. For stars of the same declination, the variation in the times will be proportioned to the variations in the thickness of the glass. But since the logarithm of the light transmitted varies as the thickness of the glass, and the stellar magnitude varies as the logarithm of the light, it follows that the time will vary as the magnitude. For stars of different declinations, the times of traversing a given distance will be proportional to the secant of the declination. If δ, δ' are the declinations of two stars having magnitudes m and m', and t, t' are the times between their transits over the bar and their disappearances, it follows that $m' - m = \text{A} (t \sec \delta - t' \sec \delta')$. For stars in the same declination calling $\text{A} \sec \delta = \text{A}'$ we have $m' - m = \text{A}' (t - t')$. Accordingly the distance of the bar from the edge of the wedge is unimportant, and, as in Prof. Pritchard's form of the instrument, it is only necessary to determine the value of a single constant, A. Various methods may be employed to determine this quantity. Prof. Pritchard has recommended reducing the aperture of the telescope. This method is open to the objection that the images are enlarged by diffraction when the aperture is diminished; constant errors may thus be introduced. Changing the aperture of a large telescope requires some time, and in the interval the sensibility of the eye may alter. These difficulties are avoided by the following method, which may be employed at any time. Cover the wedge with a diaphragm in which are two rectangular apertures, and place a uniformly illuminated surface behind it. Bring the two rectangles into contact by a double image prism, and measure their relative light by a Nicol. From the interval between the rectangles and the focal length of the telescope, the light in magnitudes corresponding to one second, or A may be deduced. Perhaps the best method with a small telescope is to measure a large number of stars whose light has already been determined photometrically, and deduce A from them.

The great advantage claimed for this form of wedge photometer is the simplicity of its construction, of the method of observing, and of the computations required to reduce the results. It may be easily transported and inserted in the field of any telescope like a ring micrometer. The time, if the observer is alone, may be taken by a chronograph or stop-watch. Great accuracy is not needed, since if ten seconds correspond to one magnitude, it will only be necessary to observe the time to single seconds. The best method is to employ an assistant to record and take the time from a chronometer or clock. If the stars are observed in zones, the transits over the bar serve to identify or

---

[1] By Prof. Edward C. Pickering. Presented May 10, 1882, at the American Academy of Arts and Sciences.

locate them, as well as to determine their light. A wedge inserted in the field of a transit instrument will permit the determination of the light of each star observed without interfering with the other portion of the observation. If the stars are all bright, time may be saved by dispensing with the thin portion of the wedge. In equatorial observations of asteroids the light may be measured photometrically with little additional expenditure of time. Perhaps the most useful application would be in the observation of zones. When the stars are somewhat scattered it would often happen that their light might be measured without any loss of time. By this instrument another field of usefulness is opened for the form of horizontal telescope advocated at a former meeting of this Academy (*Proc. Amer. Acad.* XVI. 364). Very perfect definition would not be required, since it would affect all the stars equally. To an amateur who would regard the complexity of an instrument as a serious objection to it, a means is now afforded of easily reducing his estimates of magnitude to an absolute system, and thus rendering them of real value.

ELECTRICITY ON PIKE'S PEAK

THE following extracts relative to electricity, from Pike's Peak Monthly Abstract Journals, have been very kindly forwarded to us by General Hazen, the chief of the U.S. Signal Service, in accordance with a request made by us; we believe their publication will prove useful:—

November 23, 1873.—Atmospheric electricity manifested itself when line was broken by a crackling sound when binding screws were touched, and bright sparks drawn when storepipe was touched by my fingers.

December 7, 1873.—While line was broken I heard relay working; thinking line had been repaired, I hastened to adjust; received a severe shock, which convinced me that something stronger than our battery had charged the wire. Instrument cut out and lightning arrester screwed closer; in a few minutes a continuous stream of electricity passed between the two plates of the arrester with a loud noise, resembling that produced by a child's rattle; the fluid passed not in sparks, but in five or six continuous streams of light, as thick as a pencil lead, for two or three minutes at a time, with short intervals between; this continued for over an hour.

December 11, 1873.—On retiring I accidentally touched my drawers with two fingers of my hand, and drew two sparks from them. This is a common phenomenon after a snow-storm.

January 12, 1874.—Electric shocks.

January 24, 1874.—Received electric shock when opening stove door; as usual, it was not repeated.

February 25, 1874.—Same as January 24.

May 11, 1874.—During the entire day severe shocks were felt by any one touching the wire, and, the line being open, I could make plain signals with the key for about ten minutes.

May 20, 1874.— p.m., report could not be sent on account of atmospheric electricity (a thunder-storm).

May 21, 1874.—A flash of fire about two feet long leaped from arrester into the office, illuminating the rooms.

May 24, 1874.—A heavy thunder-storm passed slowly and directly over the peak; large sparks passed constantly through the arrester, while a strange crackling of the snow could be heard at times. While making the 2 p.m. observation, I heard the snow crackle as above mentioned, and felt at the same time on both temples, directly below the brass buttons of my cap, a pain as if from a slight burn. Putting up my hands, there was a sharp crack, and all pain had disappeared.

May 29, 1874.—At 6.20 a terrific storm commenced; blinding flashes of fire came into bath-rooms from the lightning-arrester and stoves; loud reports followed in rapid succession.

July 1, 1874.—A party of visitors were caught in a thunderstorm not far from the summit, and all state that they experienced peculiar burning sensations on face and hands, and heard a hissing sound proceeding from hair and whiskers.

July 9, 1874.—Heavy thunder-storm; large sparks passed through the arrester during its continuance. Mr. Copley telegraphed me this forenoon that he twice got knocked down, while repairing the line, by electric shocks.

July 14, 1874.—Thunder storm; lightning in beginning very severe. I received a very painful shock while working over the line by my fingers accidentally touching the metal of the key.

July 15, 1874.—Thunder heard in the distance throughout the evening, while strong ground currents passed through the arrester.

July 16, 1874.—Severe thunder-storm; sharp flashes and retorts came through the arrester to the terror of several lady visitors. Outside the building the electric effects were still more startling. The strange crackling of the hail mentioned before was again heard, and at the same time my whiskers became strongly electrified and repellant, and gave quite audible hissing sounds. In spite of the cap I wore my scalp appeared to be pricked with hundreds of red hot needles, and a burning sensation was felt on hands and face; several of the visitors who were outside had the same experience. A large dog who had followed his master out-doors became terrified, and made for the door with a pitiful howl. Lightning was seen in all directions in the evening, and ground currents passed incessantly through the arrester.

July 19, 1874.—A severe thunderstorm passed close over the Peak between 1.30 and 2.30 p.m.; lightning struck wire between 2nd and 3rd poles from the house; for a moment the wire resembled a rope of fire and vibrated violently for some minutes after the discharge—no damage done. Frequent loud discharges took place along the ground-wire between it and the rocks on which it rests. Hair and whiskers of anyone outdoors were electrified by each discharge.

July 21, 1874.—Heaviest thunderstorm of the season to-day; lightning terrific; constant crackling of fallen hail and peculiar clattering of the rocks as if shaken by subterranean convulsions, indicated the highly electrified state of the summit.

August 2, 1874.—I was obliged to keep the telegraph instruments cut out during the greater part of the day.

August 3, 1874.—The lightning rendered the line almost useless the entire afternoon; I got severely shocked when sending my report.

August 13, 1874.—Seventeen visitors to day; some of them made the ascent during a severe thunderstorm, and were much alarmed by the effects of the electricity upon their hair, one of them declared that his hair stood up so stiffly as to lift off his hat!

October 5, 1874.—Severe thunderstorm below summit in afternoon, observers severely shocked whilst calling Fenton at lower station.

May 22, 1875.—During storms to-day (hail and snow) electricity quite strong.

May 23, 1875.—Electricity strong at intervals during day and night.

May 24, 1875.—Hail from 3.55 p.m. till midnight, accompanied by very strong electricity, decreasing and increasing in intensity, a notable fact in all hail-storms.

May 25, 1875.—Electricity has shown itself nearly all day with variable force (hail frequent during the day).

May 29, 1875.—Hail about midday accompanied by electricity. In all our hailstorms the fall of hail entirely ceases for about a half a minute, following a heavy electric discharge, and the hailfall is considerably heavier for some little time following the discharge than before.

July 5, 1875.—Terrible electric storm in afternoon, at first its effects were felt only by the line, but about 2 p.m. its presence was evident everywhere on the summit; a constant stream of flame from the arrester; a constant crackling noise heard out of doors as though made by small pistols.

May 11, 1876.—During hailstorm at 7.30 I was compelled to cut out the wires owing to intensity, this I attempted with ungloved hand, and learned a lesson that was an impressive one; luckily I escaped with a slightly bruised head and a fearful scare.

May 25, 1874.—During a thunderstorm the wire outside, at two or three places, kept up a peculiar singing noise, resembling the singing cricket. I have previously noticed that the singing noise is never heard except when the atmosphere is very damp, and rain, hail, or snow is falling.

June 16, 1876.—At 5.20 p.m., as I was sitting on a rock near the monument, on the eastern edge of the summit, a blinding flash of lightning darted from a cloud seemingly not more than 500 feet north-east of me, and was accompanied by a sharp, quick, deafening report, and at the same time I felt the electricity dart through my entire person, jerking my extremities together as though by a most violent convulsion, and leaving tingling sensations in them for a quarter of an hour afterwards. Straine, who was sowing wood in the shed at the time received a similarly violent shock, and says that a ball of lightning appeared to pass through the store-room and wood-shed in which he was working, leaving behind a strong sulphurous smell.

July 13, 1876.—Singing on the wire. It also seemed to come from the instrument shelter and the house, as well as from the wire. Thunder loud and continuous during the afternoon.

July 23, 1876.—The anemometer stopped working on account of the electric storm. Privates Straine and O'Keefe were shocked while trying to fix it, so that they had to give it up until the storm had subsided somewhat.

August 18, 1876.—A beautiful phenomenon was observed by myself, Private Greenwell, and four visitors. The peculiar singing noise (or sizzing noise) was heard again, always before in day, but this time at night, but the line for an eighth of a mile was distinctly outlined in brilliant light which was thrown out from the wire in beautiful scintillations. Near us we could observe these little jets of flame very plainly. They were invariably in the shape of a quadrant, and the rays concentrated at the surface of the line in a small mass about the size of a currant, which had a bluish tinge. These little quadrants of light were constantly jumping from one point of the line to another, now pointing in one direction then in another. There was no heat to this light, and when I touched the wire I could only feel the slightest tingling sensation. Not only was the wire outlined in this manner, but every exposed metallic point and surface was similarly tipped or covered. The cups of the anemometer appeared as four balls of fire revolving slowly round a common centre. The wind vane was outlined with the same phosphorescent light, and one of the visitors was very much alarmed by sparks, which were plainly visible in his hair, though none appeared in ours. At the time of this phenomena snow was falling.

March 27, 1877.—Singing noise heard upon the wire today.

May 12, 1877.—Hailstorm, accompanied by intense electricity.

May 24, 1877.—Sergeant Hobbs and Private Greenwell received severe shocks during the day.

August 6, 1877.—Intense electricity; all metal objects were tipped with sparks.

November 25, 1877.—Snow-storm all day attended by intense electricity, which could be heard crackling in a person's hair continuously, although no reports of thunder were heard.

December 26, 1877.—The atmospheric electricity was very intense during the day, and at times would crackle on various objects in the room.

January 25, 1878.—Several thunderstorms occurred in the surrounding parks and gulches. The electricity on the summit was very intense, causing a continuous snapping of the lightning arrester.

May 12, 1878.—A snow-storm commenced during the night, and at 1 p.m. was drifting furiously by a rising gale. The electricity varied with wind-gusts, and was so intense at times as to render our position exceedingly dangerous. The telegraph wires were cut out, but violent sparks would still jump six inches between the disconnected *windows*. One violent discharge seemed to have occurred in the chimney, for a terrible commotion was caused in the soot and ashes.

May 24, 1878.—At 8 p.m. snow commenced, attended with severe electricity, lasting for an hour. The wires had to be cut out and parted, and a vivid glaring was continuous in the windows. A lamp set in the north window would, with its flame, cast a shadow on the opposite wall for several seconds.

July 1, 1878.—During afternoon sleet fell, accompanied by intense electricity. At 3.20 a violent explosion occurred in the room, near the stove, scattering the wood and knocking down the stove-pipe.

April 10, 1879.—The telegraph wire heavily charged with a ground current of electricity this evening, and it was with difficulty that signal was transmitted. The current at times was entirely reversed.

June 16, 1879.—Light sleet, accompanied by thunder. Only a few peals were heard, when it gave way to a strong steady current over the wire, and for twenty minutes one of those electric storms peculiar and common to Pike's Peak prevailed. A queer hissing sound from the telegraph line, the wind-vane post, and other posts standing in a deep snow-drift near by. I stepped out to view the phenomenon, but was not standing in the snow-drift long, when the same buzz started from the top of my head, my hair became restless, and feeling a strange creeping sensation all over my body, I made quick steps for the station; once inside upon the dry floor, the effects soon left me. After getting inside I opened the telegraph key, and found a continuous bright spark passing between the key and the anvil, even when they were separated one-eighth of an inch; and by putting two thicknesses of writing-paper in this space, it was scorched, and perforated by numerous burnt holes. By accident I completed the circuit with both hands, when I received a shock that sent me back on the floor.

June 29, 1879.—Thunder-storm (very severe), 11.10 to 11.30 a.m., during which time a bolt passed through the arrester with a report exceeding that of a rifle, and threw sparks all over the office. The suddenness and violence of the shock stunned me, so that it was a little while before I could realise what had happened.

August 11, 1879.—During passage of a thunder-storm over the Peak a great amount of atmospheric electricity was manifested.

August 12, 1879.—Heavy snow and sleet began falling at 5.30 p.m.; at 5.40 p.m. a ball of lightning went through the arrester with the report of a rifle, throwing a ball of fire across the room against the stove and tin sheathing; the wood-packers, Messrs. Wade and McDonald, had taken refuge in the station for a few minutes, but concluded immediately that this was rather an uncomfortable place during a storm, and left immediately; their dog however was far in advance in seeking shelter outside. Mr. Wade declared that the lightning struck him in his feet and legs. At 6 p.m. the lightning struck the wire and building at the north end, where the wires come through the window and arrester with a crash equal to any 40-pounder. It burned every one of the four wires coming in at the window into small pieces, throwing them with great force in every direction, and filled the room with smoke from the burned gutta-percha insulation; the window-sash was splintered on the outside, one pane of glass broken, and another coated with melted copper. The anemometer wires were also burned up and the dial of the anemometer burned and blown to pieces. Private Sweeny was about deaf for some time afterwards. One piece of the wire was thrown with such force that when it struck the barometer three feet distant it was wound around it, without, however, doing any damage to the barometer.

July 2, 1880.—Line worked poorly on account of storm, each flash of lightning causing the instrument to be thrown out of adjustment; the signals at midnight were got off with great difficulty.

July 19, 1880.—Atmospheric electricity quite prevalent during the evening.

July 21, 1880.—Hail in afternoon and night, accompanied by heavy flashes of lightning which played around the arrester, and exploded with great force.

July 23, 1880.—Hail, rain and snow during the day; ended at 5.40 p.m. Intense ground currents during prevalence of storm.

June 23, 1881.—A light fall of hail, accompanied by terrific flashes of lightning, which snapped on the lightning arrester, and exploded with great violence.

July 4, 1881.—During the progress of the rain-storm it was accompanied by the heaviest discharges of lightning and thunder that I ever witnessed in all my experience at this station. The lightning snapped on the arrester and exploded with great violence in the office. Several times during the evening I was certain that the station building would be struck and demolished, as the lightning was almost continuous.

August 21, 1881.—Heavy hail began falling at 12.30 p.m., continued at intervals until 4.15 p.m., when it ceased. The hail was accompanied with the heaviest discharges of lightning that I ever witnessed in all my experience at this station. It was impossible to remain in the office during the progress of the hailstorm, as the lightning was almost continuous, and snapped and exploded in all directions, so that I was compelled to retreat to the kitchen for safety. The south-west portion of the station-building was struck by lightning, but no damage of any consequence was done, nor was the station-building impaired by the shock. The lightning arrester and ground wires were badly damaged, but the worst feature of the storms was the fact that both the station and extra barometers were also struck, and the cisterns of both cracked.

During the storm a shepherd was killed by lightning, and when found was stripped of his clothing and boots; he had taken refuge under a tree.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

EDINBURGH.—Five Fellowships in connection with this University (the gift of an anonymous donor) of the value of 100*l*. each, for one year, but renewable for one or two further years at the pleasure of the Senatus Academicus, will be open to applicants in October next. There will be no examinations for election to these Fellowships, but Fellows will be elected by the Senatus Academicus after consideration of the qualifications and circumstances of the applicants. The Fellowships are open to any graduate of a Scottish University, not being more than thirty years of age at the date of application, and provided that he be not an assistant to any Professor, or an examiner in any department. They are intended for persons having attained some proficiency in, and who are desirous to prosecute, unprofessional study and research in one of the following subjects:—Mathematics (pure and applied), or experimental physics, chemistry, biology, mental philosophy, history, or the history of literature. Persons desiring to hold one of these Fellowships should address an application to the secretary of the Senatus, with statement as to previous course of study, and general purposes with respect to future work. Each Fellow will be expected to reside in Edinburgh during the winter and summer sessions of the University (1882-83) to prosecute his particular branch of study under the advice of the Professor to whose department the subject belongs; and within a year after his election to give evidence of his progress by the preparation of a thesis, the completion of a research, the delivery of a lecture, or in some other way approved by the Senatus Academicus. No other fellowship, scholarship, or bursary, in this or any other University, will be tenable together with one of the elective Fellowships.

THE budget commission of the French Chamber of Deputies have printed their estimates for public instruction for 1883. They claim 5½ millions sterling, irrespective of the sums granted by departments for the same purpose. About half of this sum is claimed for elementary instruction, exhibiting, an addition of more than 800,000*l*. on the credit given for 1882. This is in prevision of the working of the law of compulsory education. The more notable items are the following:—Government grant to the grammar schools for young ladies, 12,000*l*.; national library, extraordinary expenses for printing the catalogue, 2000*l*.; ordinary expenses, 21,000*l*.; other public libraries, 12,000*l*.; aid to men of science and letters, 8000*l*.; scientific travelling and exploring, 8000*l*.; College de France, 19,000*l*.; Museum of Natural History, 36,000*l*.; Institute of France, 28,000*l*., of which 8000*l*. are granted to the Academy of Sciences; Academy of Medicine, 3000*l*.; School of Hautes-Etudes, 12,000*l*.; astronomical and meteorological establishments, 35,000*l*.; including a school for astronomers, which has been opened at the Observatoire of Paris, but will be closed as soon as the several French observatories will have procured a sufficient number of trained observers. The commission refuse to grant money to the meteorological observatory of Mount Ventoux.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, June.—On the several efficiencies of the steam-engine, and on the conditions of maximum economy (continued), by R. H. Thurston.—Ninety miles in sixty minutes (continued), by W. B. Le Van.—Ringing bells, by J. W. Nystrom.—Radio-dynamics; universal phyllotaxy, by P. E. Chase.—A thermograph, a new apparatus for making a continuous graphical record of the variations of temperature, by G. M. Eldridge.—Electricity, by A. E. Outerbridge, jun.—An essay on mechanics and the progress of mechanical science, 1824-82, by F. Finley.—Device for increasing the dynamic effect of the pulsations of diaphragms and the like, by W. B. Cooper.—Influence of pulley-diameter on the driving power of flat belts, by R. Grimshaw.—Recent improvements in the mechanic arts, by F. B. Brock.

Bulletin de l'Academie Royale des Sciences de Belgique, No. 4.—History of the Imperial and Royal Academy of Sciences and Belles-Lettres of Brussels, by M. Mailly.—On the dilatation of alums, by M. Spring.—One word more on the determination of latitude, by M. Folie.—On the rocks of the island of Fernando Noronha, gathered during the *Challenger* expedition, by M. Renard.—On the state of vegetation, March 21, 1882, by M. Dewalque.—On the respiratory variations of the sanguineous pressure in the rabbit, by MM. Moreau and Lecrenier.—Mineralogical examination of the rocks which accompany the diamond in the mines of the Cape of Good Hope, by M. Meunier.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, vol. xv., fasc. ix.-x.—On the nature and origin of tumours occasionally found free in the abdominal cavity, by S. Sangalli.—Presentation of a piece of wood from Brazil, with the apparent figure of a serpent, by Dr. Mantegazza.—On protistological examination of the water of Lake Maggiore, extracted at 60 metres depth, between Angera and Arona, by S. Maggi.—Zoological notes, by S. Pavesi.

Rivista Scientifico-Industriale, April 30 and May 15.—New seismic apparatus of the Brothers Brassart, by S. E. Brassart.—The comets seen in the last ten years and Comet Wells, by S. Zona.—On sounds produced by outflow of liquids, by S. Martini.—On succinine, by Drs. Funaro and Danesi.—*Sinaxylon muricatum*, Fab., in the Romagna, by S. Rovelli.—The story of a flint stone, by S. Mascarine.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, June 20.—Dr. A. Günther, F.R.S., vice-president, in the chair.—The Secretary exhibited a series of the diurnal and nocturnal Lepidopterous insects bred in the Insect House in the Gardens during the present season, and called attention to several specimens of clear-winged Moths (*Sesiidæ*), a group of insects which had not before been exhibited in the Insect House. The cocoon of *Cricula trifenestrata*, together with the imago, was also exhibited.—Mr. W. A. Forbes made remarks on the presence of a rudimentary hallux in certain birds—the Albatrosses and two genera of Woodpeckers (*Tiga* and *Picoïdes*), commonly described as being three-toed, and exhibited preparations showing its condition in the birds in question.—Prof. Owen read the twenty-fifth of his series of memoirs on the *Dinornis*. The present communication gave a description of the head and feet, with their dried integuments, of an individual of a species supposed to be called *Dinornis didina*. These specimens had been obtained by Mr. H. L. Squires at Queenstown, South Island of New Zealand, and being parts of one individual tended to elucidate in an unlooked for degree the external characters of the Moa.—A second communication from Prof. Owen contained some observations on *Trichina spiralis*.—Prof. E. Ray Lankester gave a description of the valves of the heart of *Ornithorhynchus paradoxus*, and compared them with those of man and the rabbit. Prof. Lankester also made some observations on the *fossa ovalis* of the Monotremes.—Prof. Huxley, F.R.S., read a description of the respiratory organs of *Apteryx*, which he showed did not differ fundamentally from the Avian type, and pointed out that neither of the structures that had been termed diaphragms in the *Apteryx* was really in correspondence with the Mammalian diaphragm.—Mr. W. A. Forbes read the sixth of his contributions to the anatomy of Passerine birds. In the present communication the author showed that *Xenicus* and *Acanthisitta*, hitherto considered to be allied to *Certhia*, *Sitta*, and *Sittella*, were really mesomyodian forms, most nearly allied perhaps to *Pitta*. The discovery of such low forms of Passerine birds in New Zealand was a fact of considerable interest, none of the allied groups being at all represented there at the present day.—A communication was read from Mr. Sylvanus Hanley on the shells of the genus *Leptomya*, to which was added the descriptions of two new species.—Mr. Sclater read a note on Rüppell's Parrot, and showed that the more brightly-coloured individuals, ordinarily supposed to be the males of this parrot, were really the females.—A second paper from Mr. Sclater gave the description of two new species of the genus *Synallaxis* from the collection of Messrs. Salvin and Godman.—A communication was read from Prof. M. Watson containing an account of the muscular anatomy of *Proteles* as compared with that of *Hyæna* and *Viverra*.—Mr. Oldfield Thomas read a paper containing a description of a new species of Rat from China. The specimens upon which the author had founded the description had been sent by the Abbé Armand David to Mr. Milne-Edwards, of Paris, who had placed them in the hands of Mr. Thomas for identification. The author proposed to call this Rat *Mus Edwardsi*.—A communication was read from Mr. E. W. White, F.Z.S., of Buenos Ayres, in which he gave an account of the birds collected by him in the Argentine Republic.—Mr. R. Bowdler Sharpe read the descriptions of two apparently new species of *Erythropygia*, one from the Zambesi, the other from the Congo River, which he proposed to call respectively *E. zambesiana* and *E. ruficauda.*—A second paper by Mr. Sharpe contained the description of a new Flycatcher which had been obtained by the late Governor Ussher on the Gold Coast. The author proposed to call it *Muscicapa ussheri*, in acknowledgment of the services which its discoverer had rendered to ornithological science.—A communication was read from Mr. F Moon on the Lepidoptera collected by the Rev. J. H. Hocking, chiefly in the Kangra District, N.Y. Himalaya. The present communication, being the second on the same collection, contained the descriptions of seven new genera and of forty-eight new species. An account of the transformation of a number of the species was also given.

Physical Society, June 24.—Prof. Clifton, president, in the chair.—New Members: Prof. Bartholomew Price, Principal Viriamu Jones.—Prof. G. Carey Foster moved a vote of thanks to Prof. Clifton for the excellent reception accorded to the Physical Society at Oxford on the preceding Saturday, and drew attention to the high efficiency of the Clarendon Laboratory and the admirable provision made for the teaching of physics at Oxford. Prof. W. G. Adams seconded the motion, and endorsed Prof. Forster's views of the position of physical science on the Isis. Prof. Clifton in response to the vote, stated that the University of Oxford had liberally supported him in organising the Clarendon Laboratory, giving him all the funds he required, and showing a laudable desire to put physical teaching on the best possible footing in Oxford.—Prof. C. A. Bjerknes of Christiania, was then introduced to the meeting, and, assisted by his son, M. Vilhelm Bjerknes, delivered a lecture on "Hydrodynamic Analogies to the Phenomena of Electricity and Magnetism," which was illustrated by experiments and projections on the screen. Prof. Bjerknes has been engaged in tracing these analogies for the last twenty-five years, at first mathematically, but latterly by experiments in verification of the deductions from his formulæ. These experiments were shown in the Paris Electrical Exhibition last year, and have been published repeatedly in this country. Dr. Bjerknes has, however, advanced beyond the results there shown. These were chiefly confined to illustrating the static attractions and repulsions of electricity and magnetism; but he has now taken up the subject of electrodynamic attractions and repulsions. The former effects are shown by brass balls oscillating, or by small tambours pulsating, near each other in water. These motions are communicated to the balls and drums by pulses of air transmitted from an ingenious air-pump or bellows along india-rubber tubes. A pulsating drum corresponds to a magnetic pole; an oscillating body to a magnet. When two tambours are vibrating near each other in like phase, they attract; when in unlike phase, they repel each other. The same holds true of the oscillating balls. The motion-lines round these bodies correspond to the lines of force round magnets, as was demonstrated by a hollow ball oscillating or a stem, and tracing its movements in ink on a glass plate. All the phenomena of magnetic forces were illustrated in this way by Prof. Bjerknes, including diamagnetism, which was shown by means of pith cylinders lighter than the water or medium of oscillation. A pulsating drum or oscillatory ball repelled the cylinder of pith, whereas it attracted a cylinder of wax, which is heavier than the water. The more novel part of the experiments consisted in representing the attraction between two electric currents flowing in the same direction by means of two cylinders about five inches long and one inch in diameter, oscillating round their longitudinal axes at close quarters in the water. The cylinders were oscillated by means of a pulsating tambour which communicated its motion to them by a toothed gearing on their ends. Attraction resulted when the oscillations of the cylinders were opposed to each other, and repulsion when they were in the same direction. This is an inversion of what might have been expected to take place after the theory of Ampère. A square of four oscillating cylinders was also formed, and a fifth cylinder oscillated inside it, the attraction or repulsion exerted on the latter being observed. A hydrodynamic galvanometer was made by placing an oscillating ball (which corresponds to a magnet) beside an oscillating cylinder, the result being a deflection of the ball according to the direction of the oscillation of the cylinder. The experiments were witnessed by a full meeting, which accorded a hearty vote of thanks to Dr. Bjerknes.—A paper by Dr. C. R. Alder Wright, F.R.S., was taken as read. It was on the determination of chemical affinity in terms of electromotive force (Part vi.), and on the relations between the E.M.F. in cells constructed like Daniell's cells, but containing different metals, and the chemical affinities involved in their actions. The cells employed were constructed of cadmium and copper, and their sulphates, zinc and cadmium and their sulphates, zinc and silver and their sulphates, cadmium and silver and their sulphates, copper and silver and their sulphates. In all cases the sulphate solutions were of equal molecular strengths. The general result is that the effect of a given alteration in the character of the plates opposed to cadmium or silver was found to be practically identical with that of the same alteration in the case of a Daniell cell. Volta's law of the summation of E.M.F. forces sensibly holds true in the cases examined. These cells also behave like a Daniel under variations of current density. The Society meets again in November.

Geological Society, June 21.—J. W. Hulke, F.R.S., president, in the chair.—Robert Bruce Napoleon Walker was elected a Fellow of the Society.—The following communications were read:—On *Thecospondylus horneri*, a new Dinosaur from the Hastings Sand, indicated by the sacrum and the neural canal of the sacral region, by Prof. H. G. Seeley, F.R.S., F.G.S.—On the dorsal region of the vertebral column of a new Dinosaur, indicating a new genus, *Sphenospondylus*, from the Wealden of Brook, in the Isle of Wight, preserved in the Woodwardian Museum of the University of Cambridge, by Prof. H. G. Seeley, F.R.S.—On organic remains from the Upper Permian strata of Kargalinsk, in Eastern Russia, by W. H. Twelvetrees, F.G.S. In this paper the author described the Kargalinsk steppe, north of Orenburg, as consisting of a grassy, treeless, undulating steppe, with sluggish, winding streams, in the banks of which, and in the ravines, the exposures of subsoil show only red marl or sandstone devoid of fossils. Mine-borings and shafts go down through red, yellow, and grey sandstones and red and white marls, which are fossiliferous wherever the beds of copper-ore exist. On the eastern border of the steppe there are two protrusions of limestone, with *Terebratula elongata*, *Loxonema*, &c., on outcrops running nearly north-west and south-east, which throw off the cupriferous sands east and west. The western of these outcrops in its southern continuation near Sakmarsk is charged with Permian Fossils, including the above; the same limestone, regarded by the author as belonging to the Zechstein, crops up in other places, and apparently underlies the whole basin of the steppe, the upper sandstones resting conformably upon it. From the latter the author gave the following list of fossils:—*Cardiopteris Kutorgæ* (= *Aroides crassispatha*), *Walchia biarmica* and *piniformis*, *Lepidodendron*, *Schizodendron tuberculatum*, *Anomorrhœa Fischeri*, *Caulopteris?*, *Calamites infractus*, *Suckowi gigas* and *leioderma*, *Unio umbonatus*, *Platyops Richardi* (a Labyrinthodont), *Rhopalodon Wangenhäuseri*, *Cliorhizodon*, *orenburgensis*, *Deuterosaurus*, and various Labyrinthodont and Reptilian remains. Upon these the author remarked that the list of plants has a Palæozoic aspect, while the Reptilian remains seem to be more of a secondary character. After consideration of all the facts, the author came to the conclusion that possibly some of the beds in the central part of what is known as the Permian basin may be passage-beds between the Permian and Trias, but that the Kargalinsk series includes the uppermost beds of the Permian.—The Rhætics of Nottinghamshire, by E. Wilson, F.G.S.—On the Silurian and Cambrian strata of the Baltic provinces of Russia, as compared with those of Scandinavia and the British Islands, by Dr. F. Schmidt. Communicated by Dr. H. Woodward, F.R.S., F.G.S. The Cambrian and Silurian strata in question are found stretching over an area 400 miles long by 80 miles wide. The country occupied by these strata is a nearly uniform plain covered by glacial deposits, but sections are presented by the sea-cliffs, which are from 90 to 150 feet high. The strata consist mainly of marls and limestones, arenaceous deposits being rare, and they form a continuous series from the base of the Cambrian to the top of the Silurian, the whole of these strata being in conformable succession and unconformably overlain by the Devonian. Although the representative of the Cambrian or Primordial Silurian contains neither *Paradoxides* nor *Orlenus*, nor, indeed, any Trilobites whatever, but only Lingulidæ and Graptolites, yet its stratigraphical position leaves no doubt as to its age.—On Chilostomatous Bryozoa from Bairnsdale (Gippsland), by A. W. Waters, F.G.S.—The Silurian species of *Glauconome*, and a suggested classification of the Palæozoic Polyzoa, by G. W. Shrubsole, F.G.S., and G. R. Vine.—On the cause of the depression and re-elevation of the land during the glacial period, by T. F. Jamieson, F.G.S.

EDINBURGH

Royal Society, June 19.—The Right Hon. Lord Moncreiff, president, in the chair.—Prof. Tait, in Part III. of his paper on Mirage, called attention to an elaborate Memoir on the subject by Biot, who had anticipated him in many particulars. Biot had pointed out the existence of the curve of vertices, which Prof. Tait made the basis of his discussion, but had not made any use of it, preferring to investigate the phenomena by means of the caustics—a much more difficult method. Further, in his explanation of the appearances described by Vince, Biot regarded the rays as being for the first part of their course concave upwards—a state of affairs which Prof. Tait regarded as very unlikely. Such a point, however, could be settled only by careful measurements of the dip of the horizon taken at different heights above sea-level.—Dr. Dobbie and Mr. G. G. Henderson, B.Sc., communicated the results of their analysis of the red resin obtained by Prof. Bayley Balfour, from the Socotra species *Dracœna Cinnabari*, and of their comparisons between it and other specimens of dragon's-blood. These they found to differ considerably, specimens going by the same name being often markedly distinct in their chemical properties. They concluded that of the several distinct and well-defined varieties which they had investigated, each was probably derived from a distinct genus, different species of the same genus yielding the same resin.—Prof. Crum Brown read a paper by the Rev. J. L. Blake, on breath pressure. This paper was a careful analysis of the individual efforts or distinct breath-pulses by which articulated utterance is effected, and by which emphasis is regulated; and was illustrated by examples selected from various authors.—In a preliminary notice on the effect of moisture on the electric discharge, Dr. Macfarlane and Mr. Rintoul mentioned that they had obtained indications that the difference of potential required to cause the discharge between two plates was greater in dried than in undried air.—Prof. Crum Brown communicated a note by Mr. A. P. Laurie and Mr. C. I. Burton, on the heats of combination of the metals with the halogens, which they had compared by the electrometer method, assuming Sir W. Thomson's formula which expresses the electromotive force of a cell in terms of the thermal equivalent of the chemical action. The results obtained were in fair agreement with those of direct calorimetric experiment.

GÖTTINGEN

Royal Society of Sciences, August 6, 1881.—On the Biehler collection of gems, by F. Wieseler.

December 3, 1881.—Observations in the Gauss Magnetic Observatory, by K. Schering.

May 6, 1882.—On the geological structure of the neighbourhood of Göttingen, by A. von Kœnen.—Contribution to knowledge of the inflammatory force of retarded discharges, by W. Holtz.

June 13, 1882.—Whence comes the x of mathematicians, by P. de Lagarde.

PARIS

Academy of Sciences, July 3.—M. Jamin in the chair.—It was announced that the *Romanche*, with the expedition for Cape Horn, would sail that week. Good wishes were expressed, also thanks to the Naval Minister for carrying out the Academy's request.—On the appearances of the electric arc in sulphide of carbon vapour, by MM. Jamin and Maneuvrier. When a little of the sulphide is brought into the vacuous receiver, there occurs an explosion, as it were, of brilliant unbearable light between the (parallel) carbons; the persistent arc is of horse-shoe form, and pale green, and a long flame rises above. The spectrum consists of four channelled spaces, quite alike, in red, yellow, green, and violet, the green, however, being most luminous. If air have remained in the jar, sulphur is deposited on the walls; if not there is a brown deposit, probably a compound of sulphur and carbon.—On the electrolysis of oxygenated water, by M. Berthelot. The minimum force required was a Daniell. The electrolytic reactions and heat consumed are shown to be in correlation with the electromotive forces.—On the electromotive force of a zinc-carbon element, by M. Berthelot. His experiments (with the Mascart electrometer) show the unfitness of the zinc carbon element to give a constant electromotive force.—M. Berthelot gave some observations on the Channel Tunnel, which he had visited.—Analysis of the mechanism of locomotion by means of a series of photographic images on one plate, representing successive phases of the motion, by M. Marey.—On the second comet of 1784, by M. Gyldén.—On the decomposition of protochloride of gallium by water, by M. Lecocq de Boisbaudran. Metallic gallium is dissolved in the cold state in concentrated hydrochloric acid. The The clear liquid produced, left to itself, yields gas very slowly, but if water be added, "in torrents."—On the mechanism of stoppage of hemorrhage, by M. Hayem. The hematoblasts play an active and considerable part in it, becoming adhesive when they reach the edge of a wound (as when they meet a foreign body), accumulating, stopping others, and so narrowing the orifice. The other elements of blood and the formation of fibrine have only a secondary *rôle*.—MM. Pellicot and Jaubert recommended sulphate of iron as a remedy for phylloxera.—On a new series in elliptic functions, by M. Faa de Bruno.—On entire transcendants, by M. Poincaré.—Researches on the use of crusher manometers for measurement of pressures developed by explosive substances, by MM. Sarrau and Vieille. The authors seek to render the indications of these instruments more definite.—On the theory of equipotential figures obtained by the electro-chemical method, by M. Guébhard.—Determination of the densities of vapour in glass globes at the boiling temperature of selenium, by M. Troost. With glass globes of small fusibility, and 300 c.c. capacity, he finds iodine vapour to have still at 665° a coefficient differing very little from that of air, while even at 440° its coefficient of compressibility is notably different from that of air. Sulphur vapour passes, like oxygen, from one allotropic state to another as the temperature rises.—Some remarks on didymium, by M. Clève.—Action of sulphuretted hydrogen on chloride of nickel, by M. Baubigny.—On the isomerism of cupreous sulphites, by M. Etard.—Reduction of certain silver ores by hydrogen and the wet process, by M. Laur. Wherever hydrogen appears in a liquid containing sulphide, chloride, bromide, and iodide of silver, a hydrogen acid is formed, and the silver passes to the metallic state.—Action of chloroform on β-naphtol, by M. Rousseau.—Introduction into industry of vanadium extracted from the basic scoriæ of Creusot, by MM. Witz and Osmond. The Creusot scoriæ contain vanadium estimated at 60,000 kg. annually. The authors have been able to extract either metavanadate of ammonium, or new vanadic products specially applicable to manufacture of aniline blacks with chlorates.—On an anomaly of the eye, by M. Dareste. He has noticed arrested development of the eye (reduced to the secondary optic vesicle) in anomalous or monstrous embryos.—On the histology of *Ciona intestinalis*, by M. Roule.—On the development of Gregarinæ and Coccidæ, by M. Schneider.—Use of oxygenated water in surgery, by MM. Peau and Baldy. The substance may be advantageously substituted for alcohol or carbolic acid in treatment of wounds, ulcerations, deep abscesses, &c. M. Bert remarked on the killing of microbes, and the incessant libation of oxygen to the wound.—Researches on a new cardiac medicament; physiological properties of *Convellaria maialis* (May lily), by MM. See and Bochefontaine. It acts like digitalis, but is without certain drawbacks to that substance. In man it has diuretic properties superior to those of any known agent.

CONTENTS

THURSDAY, JULY 20, 1882

PERMANENCE AND EVOLUTION

Permanence and Evolution; An Enquiry into the Supposed Mutability of Animal Types. By S. E. B. Bouverie Pusey. (London: Kegan Paul, Trench, and Co., 1882.)

THIS is a thoughtful little book, clearly and ably written, with the view of showing, as its Preface states, "that while Darwinism proper is improbable, evolutionism in any form is as yet unproved; while, on the other hand, the more we investigate the facts of inheritance, the more we are compelled to regard differences so slight, that they would usually be considered casual variations, as within the limits of our existing knowledge strictly permanent." Such being his theme, Mr. Pusey introduces it with the following very appropriate and judicious apology, which we quote in order to show the spirit which throughout characterises his work.

> "It may seem almost presumptuous on the author's part to attempt to reopen once more the whole question of evolution, especially as in doing so it is necessary to call in question the views of so many very eminent men of science. At the same time, any one who calls attention to any neglected facts, or who questions assumptions too carelessly allowed to pass muster, helps to elucidate the subject of which he treats, and so aids the cause of scientific knowledge, whether the particular views he propounds are right or wrong."

Having already observed that the work is one of marked ability, we have only further to preface our analysis of it by fully assenting to this justification. Although, as we shall immediately proceed to show, we do not think that Mr. Pusey has been successful in his tilt against the stone wall which has been reared by the school of Darwin, we nevertheless respect his independent disregard of mere authority, as we think that such disregard always deserves to be respected in matters of science where evidence is shown by the malcontent of clear and forcible thought of his own upon the doctrines which he undertakes to criticise.

The principal part of "Permanence and Evolution" is occupied with a criticism of the argument from classification, and especially that part of the argument which has reference to domestic animals. In the author's view Mr. Darwin has failed to prove in the case of any domestic animal that artificial selection has produced a new variety or sub-species. Thus of the varieties of the dog he says, "seeing how true they breed, I do not see why the principal and best marked (the greyhound, the mastiff, the terrier, the spaniel, &c.) should not have so existed (*i.e.* in a state of nature), and the others have been formed by crossing between them." Similarly of the pigeon he says there is no sufficient evidence to show that all the fancy-breeds were not once natural breeds which have since become extinct as such, or that their occasional reversion to the rock dove is not due to an ancient cross with it. "As these races resemble the rock dove, and each other, in everything except one or two conspicuous points, it need not surprise us that they produce perfectly fertile offspring," &c. Thus also he treats of the cases of all the other domestic animals alluded to by Darwin.

Concerning this mode of criticism, it seems enough to point out the cumulative improbability of all the domestic races of animals having once been wild (notwithstanding the apparent unfitness of some of them to a self-dependent mode of life), added to the further cumulative improbability of all these wild races having become extinct. We do not say that the hypothesis is impossible, but clearly it is so far improbable that even if there were no other evidence of the mutability of animal types, it would be more likely that the domestic races had been produced by artificial selection (and so that animal types are thus far changeable) than that they are all the remnants of more or less fantastic natural forms now as such extinct. If the hypothesis of "Permanence" has to stand upon so improbable a supposition as this, it is so far a less reasonable hypothesis than that of "Evolution," and therefore Darwin is justified in adducing the facts in question as evidence of transmutation to this extent.

But Mr. Pusey carries his criticism further than this, and says:—

> "Granting that natural selection with spontaneous variation could within the period of history develop out of a rock dove a fantail, I do not see how we are any nearer the conclusion that in ten times or a hundred times that period these causes would develop the Goura pigeon; granting that, that a millionfold as much time would evolve any of the true Gallinaceæ."

This way of treating the evidence is, however, hyper-critical. It is certain that either "Permanence" or "Evolution" is the truth, and therefore, if it were established, or taken for granted, that within the historic period selection is able so far to change an animal type as to convert a rock dove into a fantail, the presumption becomes immense that in a hundred times that period the operation of similar causes might develop a Goura pigeon. Thus, in view of the supposed assumption or proof we certainly *are* "nearer the conclusion" in question than we should be in the absence of a case analogous in kind though not in degree.

Similarly in dealing with the argument from affinity, we think that Mr. Pusey is hyper-critical. He points to the fact that crystals occur in natural systems, and that their similarities cannot be due to genetic descent; but this analogy is clearly too lame to support any weight of argument, and the same remark applies to his analogies drawn from the similarities found in inorganic nature generally. For in all these cases the similarities occur in objects of far less complexity than organised structures, and therefore the similarities are much less remarkable, while in the case of organisms the known facts of heredity furnish much the most probable explanation of the much more complex similarities. This, perhaps, may most briefly be shown by quoting the alternative hypothesis which our author presents, for clearly it is one which no man of the commonest judgment could for a moment entertain. He suggests that systematic affinity may be due to the resemblance between the chemical elements (? and compounds) of which organisms are made up, and adds what we must regard as a scarcely serious observation—"This hypothesis, though totally without positive evidence to support it, is in itself quite as clear and definite, and (what is called) explains the facts about as well as the hypothesis of evolution."

Mr. Pusey's treatment of the evidence from rudimentary organs does not seem to us more fortunate. His only criticism here is that because organs are rudimentary we have on this account no warrant for concluding that they are useless; "if these aborted structures were the only ones in which we could see no use, then the explanation would have some *locus standi*." But here the important fact is lost sight of that all rudimentary organs are the *homologues* of organs which when of larger size present observable utility. Can it be reasonably supposed that in the case of all the thousands of these "aborted structures," some new function, always unobservable, is performed by an organ which by some strange chance happens to be the homologue of an organ which when of larger size performs some other and observable function?

Again, the argument from embryology obtains but very scant justice; only three pages are devoted to it, and the core of the subject is not touched. For the force of this argument does not consist in our seeing "a vast number of animal forms, many of which are very like each other, and their distinctions less pronounced in youth," or in such cases as that of the stripes on the young lion, &c. The force of the argument consists in the progressive imitation of lower morphological types by the successive embryonic stages of higher ones; and of this very remarkable fact Mr. Pusey takes no notice.

The argument from palæontology is dismissed in a similarly high-handed fashion, but somewhat more consideration is given to the argument from geographical distribution. The view advanced is "that the facts of distribution can, to a great extent, be shown to have originated in an opposite manner, not by the origination of new forms, but by the destruction of old ones." If this could be shown, no doubt the proof would be one of much importance to science, and would serve largely to modify the argument from distribution; but the fact certainly has not been proved, or even shown to be generally probable, by the book before us.

Concerning the specially Darwinian theory of evolution Mr. Pusey says that personally he thinks "whatever else is the origin of species, natural selection certainly is not." His reasons for this opinion are that *a priori* the way in which we should expect natural selection to act "would be by conferring fertility, hardiness, and early maturity" (none of which qualities are presented by the higher Primates); and also that allied animals living on the same areas and apparently exposed to similar conditions of life, are nevertheless "dissimilar in a number of minor points, apparently unconnected and without teleological purpose." Now concerning the first of these objections, it seems enough to observe that *a priori* considerations of this kind are extremely hazardous. Fertility. hardiness, and early maturity may all be good for species, and yet other qualities (perhaps incompatible with them) may be even better, such as high nervous organisation, intelligence, &c. In short, where the conditions of the problem in any given case are so many and complex, it would be idle to determine beforehand what qualities we should expect natural selection to lay a premium upon—as much so, for instance, as to say, after the event, that a man would be better suited in his environment if he had had a very much more brutal constitution, could run about like a chicken when a few hours old, and was the most prolific animal in creation. And of course the other difficulty, being of a similarly *a priori* kind, admits of being similarly met. There may be a thousand unobservable reasons why, after a long course of evolution, allied species living on the same areas should be dissimilar in minor points of structure, colour, &c.

We have now briefly noticed all the leading points in Mr. Pusey's criticism, and if we had more space we might go more in detail with him. But we have said enough to show that we deem his strictures throughout to err on the side of over-scepticism. In science, as in everyday life, true judgment is shown, not by suspending our decision until a theory is demonstrated by observation, but by yielding assent to probability in a degree commensurate with the evidence. At the same time, it is, of course, most important that a clear distinction should always be drawn between a probability, however high, and a proved fact. In every department of inquiry, therefore, the hyper-critical mind is of service in insisting upon this distinction when there is danger of its being neglected; and in view of this consideration we think there are many evolutionists who would do well to read Mr. Pusey's work. As we have already said, we do not consider that this work has in any way affected the main evidences of evolution; but it is well calculated to steady the course of speculative thought in a direction where with less hurry there may be more speed.

GEORGE J. ROMANES

CRYSTALLOGRAPHY

Geometrische Krystallographie. Von Dr. Th. Liebisch (Leipzig: Wm. Engelmann, 1881.)

THIS is the most complete and exhaustive book on crystallography which has been so far published, and it is especially characterised by the importance assigned to the dualism observed in crystallographic problems considered as relations of a system of planes or lines connected together by the law of rational indices. The book consists of three main parts—the first dealing with the general relations of a system of planes and lines subject to the law of rational indices; the second with crystallographic representation and construction; and the third with the developments of the six crystallographic systems and the determination of crystals.

The general problems in the first part are treated by the processes of modern geometry. The problem of the transformation of the axial system is very exhaustively treated, but curiously enough Dr. Liebisch seems unacquainted with the elegant solution of this problem, given by the late Prof. Miller in his Tract on Crystallography (1863). The analysis of this problem, given by Dr. Liebisch, is laborious and somewhat complicated, and the results are not really more general than those of Prof. Miller. Dr. Liebisch has entered into the question of the conditions of perpendicularity in a crystal system, but his analysis is not so elegant as that of Prof. H. J. S. Smith, nor is it capable of more ready application than the latter. The chapter treating of this portion of the subject is largely occupied by the proofs of the ordinary propositions of spherical trigonometry by means of a cumbrous notation and an analysis of great difficulty. One can hardly believe that this analysis is needed by

German students, and its introduction is to be regretted, as it is likely to deter scientific students from taking up crystallography.

In the special part devoted to the several systems, Dr. Liebisch proceeds from the principle of symmetry, in which, however, he defines his systems by means of axes and a centre of symmetry, instead of by planes of symmetry. This is done with a view to include the hemihedral forms in the same definition as the holohedral ones, and to obviate the difficulty arising from the hemihedral forms being excluded when the system is defined by means of planes of symmetry. One doubts, however, whether the advantage gained is sufficient to compensate for the loss of simplicity. Dr. Liebisch has made a curious slip in his definition of symmetry, being apparently carried away by his love of generalisation. He shows that the internal and external bisectors of an angle divide symmetrically the spaces portioned out by this angle, and that the four lines form a *harmonic* pencil. He then generalises this relation, and leads one to suppose that symmetry always exists when a pencil is harmonic. The fallacy of this is clear when one considers that the planes 100, 101, 001, and $\bar{1}01$ in the oblique system would thus show symmetry, since they are harmonic conjugates. Dr. Liebisch points out that the indices of the planes in a form can be deduced from those of one of the planes when the symmetry is given. The deduction though simple is sufficiently difficult, and it would have been better to have given it fully. Another omission is found in the problem of isogonal zones, *i.e.* the determination of the possible angles between planes of symmetry. The solution is carried out so far as to show that the angles must have the squares of the cosines rational, and then the special values are given. No attempt is made to show that these are all the possible cases. It is not difficult to find all the submultiples of 180° which satisfy the condition, and the complete solution has long since been worked out by Axel Gadolin and Prof. Maskelyne.

The author is remarkably well read in the literature of crystallography, and has done much to compress the valuable portion of this literature into the space of a comparatively small volume. The book is certainly not suited as a text-book for students who are beginning crystallography; and its methods of solution of crystals are not the simplest in practical work. For advanced students, who wish to regard their subject from different points of view, it will be a suggestive book; and, notwithstanding its omissions, will very greatly assist them, both by its own statements and solutions of the problems of crystallography, but also by its careful references to the literature of the subject. It is well printed, and has a large number of excellent woodcuts.

OUR BOOK SHELF

A Dictionary of Popular Names of the Plants which furnish the Natural and Acquired Wants of Man, in all Matters of Domestic and General Economy; their History, Products, and Uses. By John Smith, A.L.S. (London: Macmillan and Co., 1882.)

THE lengthy and somewhat incoherent title cited above is less expressive of the aim of this volume than the abbreviated form which appears upon its cover—viz. "Dictionary of Economic Plants." Mr. Smith, the veteran ex-curator of Kew Gardens, has brought together a great deal of information with regard to economic plants; and his facts, although sometimes open to criticism if examined in detail, are in the main trustworthy. It is not always easy, however, to reconcile the contents of the volume with its title; interesting as are such plants as the "side-saddle flower" (*Sarracenia*), "telegraph plant" (*Desmodium gyrans*), broom rape, wallflower, Virginian creeper, mignonette, and the like, they can hardly be regarded as supplying either the "natural" or the "acquired wants of man." We have tested the work somewhat carefully, and have in almost every instance found the name we were seeking; and we can therefore say that this Dictionary, although not perhaps particularly needed, may be usefully referred to by those interested in economic botany.

Induction. By Willoughby Smith. 17 pp. (London: Hayman Brothers and Lilly, 1882.)

IN this work Mr. Willoughby Smith gives an account of some curious and interesting experiments on magneto-electric induction as revealed by the Bell telephone. In one of these experiments an intermittent current was sent through a flat spiral coil of wire 36 inches in diameter containing 1220 yards of wire in 800 turns. When an ordinary Bell telephone, unconnected with the circuit, is held within a few feet of this, spiral sounds are heard in it, even if the coil of the telephone be removed, leaving only the iron tympanum and the magnet. Mr. Smith however appears to regard this effect as something not explainable on the ordinary laws of electrical action, and he applies a new term, "specific inductive resistance," to the power of a medium to stop such inductive action. He thus introduces a confusion between two conditions in the case. That such induction should be propagated depends upon the coefficient of magnetic induction, and also depends upon the damping of induction by the setting up of currents in an interposed sheet of metal. Both these causes are perfectly well known. It is a pity that an able experimenter commits himself to crude ideas of this kind. There are several good plates of figures added.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

The Mount Pisgah (U.S.) Stone Carvings

PERMIT me to make the following remarks on Dr. Rau's letter in NATURE, vol. xxvi. p. 243. I hope shortly to lay before your readers a statement of the facts relative to the objects under discussion.

At Prof. Baird's request I met him and Dr. Rau at Washington with the carvings and photographs I now have in Europe. These were looked at by Dr. Rau, and he now states as the result that he is "enabled to express an opinion concerning them," and that "they neither show the characteristics of the stone sculptures discovered in the mounds, nor do they resemble the well-known specimens of modern Indian art."

Now if Dr. Rau had compared certain of these objects with some of those found by Squier and Davis in the Scioto mounds, he might probably have "discovered," as I did some time ago, and others have observed since, some resemblance in them. Moreover, there are objects in the collection which may have been, and no doubt were, made by Indians. A striking illustration appears in a very rudely incised stone—photographs of which Dr. Rau saw; an Indian is represented with feathers in his head and a flint-lock gun in his hand. But, notwithstanding the occurrence of this and a few other similarly treated objects, the majority of these carvings do not "resemble the well-known specimens of modern Indian art." In the representations of the men and women there is a striking and peculiar physiognomy, which is the same in hundreds of the sculptures; there are other traits equally persistent, and the ornamentation—of which there is so much on the figures, tablets, and vases, is unique, and preserves a constant relation. The uniform observance of such characteristics in so large a number of objects, would seem to determine them as "typical," no matter who were the makers of them, or when they were made.

Dr. Rau believes, he says, that the "carvings" originated in comparatively modern times. I should be pleased to have any evidence either from colonial or other history of West North Carolina, that might throw light upon their production, as I have spent much valuable time in endeavouring to find such evidence.

Dr. Rau continues:—"They ('the carvings') were made by a few individuals of the Indian, or, perhaps, even of the Caucasian race." But he has already said that they *do not* "resemble the well-known specimens of modern Indian art." How, then, does he know that "they were made by a few individuals of the Indian race?" And I would ask why members either of the Indian or Caucasian races have chosen to make representations of other peoples than themselves, and with other characteristics than their own? Why Indians, who are notoriously prone to war, should have, in their representations, so carefully absented all of its indications, and emphasised the pleasures and avocations of peace? And again, why—if the "carvings" were made by a Caucasian, the maker has so studiously refrained from placing any letter, sign, or symbol, significant of his race or religion, on any of the 2000 objects?

"The rude attempts at imitating animals of the Old World," proceeds Dr. Rau, "are conclusive evidence that the makers either had seen such animals, or knew at least that they existed." Not necessarily—for they may "be rude attempts at imitating animals" of the New World. The mounds of the United States indicate that an intercourse existed between different tribes and peoples remotely separated; and, why could not peoples, while trafficking to, or emigrating from extreme points, carry with them impressions sufficiently forcible for "rude attempts at imitating," and the peccary, the tapir, and the llama, perhaps have been the models for the production of some of these apparently "Old World animals?"

Dr. Rau objects to "potstone" as a material for endurance, whereas it is found in the mounds in better state of preservation than clay pottery. He has not been made aware, perhaps, that the element of fire has caused much more damage to these carvings than "exposure." He may remember that the "carvings" were coated over with a greasy-looking soot—for their better protection, possibly, as the coating was made to penetrate well into the surface of the stone. Nevertheless, many of them are in a very bad condition. But if there were not well-preserved antiquities—and imitations also—in an admirable state of decrepitude, even in the museums, I conceive that there are more important matters to be considered in connection with these carvings than the material of which they were made.

In conclusion, it is perhaps to be regretted that Dr. Rau has not in his communication suggested any satisfactory explanation of the "curious stone carvings from the neighbourhood of Mount Pisgah, and that he leaves the subject with such dubious language as 'modern intrusion.'" MANN S. VALENTINE

Paris, July 17

Movable Coils

MR. E. OBACH's letter contains information which I am much pleased to obtain. Besides Messrs. Siemens' use of fine aluminium wire for a relay, Mr. Varley stated that it had been tried by his brother or himself for the moving coil of a syphon recorder, but without notable advantage over gold. With such currents as would be available in these two cases, no doubt slight variations in resistance would be of the utmost detriment. With the small but high-tension currents of an induction-coil, the case is materially different; whereas the lightness of the moving coil, as I endeavoured to show, enables currents "of moderate intensity" to be appreciated.

The resistance of 1 metre of copper wire 1 millim. in diameter is given in Sabine's tables as 1·06 as compared with silver, and that of aluminium 1·94. I find the the weight of the two to be respectively 2·7 and 0·99 grammes. This is, of course, when both are silk-covered. The ratio between the densities of pure copper and aluminium is 3·44. The silk covering lessens the aggregate weight of the copper, and increases that of the aluminium, so that the ratio becomes 2·72.

It is, however, obvious that, weight for weight, aluminium will carry much more electricity than copper.

The junctions of gold and aluminium have hitherto given no trouble, nor has the total resistance of the little dynamometer altered; though it has had a double railway journey, partly in third class, of about 120 miles. W. H. STONE

14, Dean's Yard, Westminster, S.W., July 15

The Analysis of the Tuning Fork

WITH reference to the letter of Mr. Stanley in NATURE, vol. xxvi. p. 243, I notice the following sentence:—"If we may apply this principle to stringed instruments, we must look rather to the bridge than the transverse motion of the string, as the communicator of the sonorous vibrations which produces the note." I thought that this was an admitted fact. Upon the shape of the bridge depends the tone of the instrument, as was satisfactorily settled by Stradivari. The bridge is usually made of spotted maple, and its thickness is of the greatest importance, for if it is too thick it will fail to respond to the string vibration. A plain piece of wood as a bridge is absolutely useless, and the tone increases as the proper shape is approximated to.

Rugby, July 14 GEORGE RAYLEIGH VICARS

The Chemistry of the Planté and Faure Cells

I HAVE read with much interest the important researches of Dr. Gladstone and Mr. Tribe into the chemistry of lead secondary batteries, and my own experience has been in general very confirmatory of their conclusions; but I am in a difficulty concerning one point in their third article, which appeared in your last issue, and I should be glad to be allowed to ask a question.

The conclusion that during discharge the reduced spongy lead is changed to sulphate of lead is, no doubt, the natural one, and it appears to be confirmed by the analysis of Messrs. Gladstone and Tribe; but then, if this is the sole product, how is the cell able to be recharged? For I find that if the plates are spread originally with $PbSO_4$, instead of with minium, it is scarcely possible to charge the cell. The coating to be oxidised will indeed allow itself to be acted on very slowly, but the coating to be reduced remains perfectly unchanged. This led me to suppose that the sulphate formed on discharging a cell was perhaps so intimately mixed with some oxide that the reducing action could as easily go on as at the first formation of the cell. But this hypothesis scarcely seems borne out by Messrs. Gladstone and Tribe's results; for though a good deal of unaltered peroxide is found after discharge on the one plate, yet on the other they speak of sulphate as being ultimately the sole-product of the discharge. It may be that they used a large excess of acid in their cells, but if so, it would be interesting to know whether either of the discharged plates refused to charge up again.

I doubt very much whether, in the cells of commerce, there is anything like enough acid present to combine with all the lead, and I think that in these a great part of the spongy lead would have to be content to oxidise itself somewhat and so remain ready to be reduced again when the charging current is applied. I by no means deny that sulphate mixed with other things can be acted on, but I do find that it is reduced with some difficulty, and when by itself not at all.

I hope, however, that my question may be the means of eliciting further information from the more extensive experience of Messrs. Gladstone and Tribe. OLIVER J. LODGE

University College, Liverpool, July 14

A Curious "Halo"

I TAKE the liberty of communicating an observation made on Saturday evening last between 8 o'clock p.m. and 8·15 p.m. of a sort of halo which appeared in the east-south-east, just over Killiney Hill. Near the horizon was a bank of heavy, slate-gray clouds coming up from the south, and from behind rose up a principal beam from the Telegraph Hill, Killiney, with two side beams of lesser intensity on the sides, at angles of about 28°–30° were lesser beams diverging from the common centre.

All those beams were *dark*, or appeared so against the sky. I mention the appearance, as the weather since has been singularly cold and rainy for the season. J. P. O'REILLY

Royal College of Science for Ireland, Stephen's Green,
Dublin, July 17

THE TRANSIT OF VENUS

WE have received the following list of selected stations for the observation of the coming transit of Venus, with the observers appointed to each, according to the arrangements, so far definitive, made by the executive committee of the Royal Society acting under the authority of the Treasury, and also the instructions prepared for the guidance of the observers.

FOR RETARDED INGRESS AND ACCELERATED EGRESS

Jamaica—Dr. Copeland, Capt. Mackinlay, R.A., Mr. Maxwell Hall.
Barbados—Mr. Talmage, Lieut. Thomson, R.A.
Bermuda—Mr. J. Plummer, Lieut. Neate, R.N.

(The Canadian Government will have three observers with six-inch instruments, besides others with smaller telescopes. These observers are acting in direct concert with the British Expeditions).

ACCELERATED INGRESS

Cape Observatory—Mr. David Gill (H.M. Astronomer), Mr. Maclear, 2nd assistant.
Montague Road, Cape Colony—Mr. W. H. Finlay (1st assistant at the Cape), Mr. Pett.
Aberdeen Road, Cape Colony—Mr. Burton, Mr. C. M. Stevens.
Madagascar—Father Perry, Father Sidgreaves, Mr. Carlisle.
Durban, Natal—A telescope has been provided by the colonists.
Mauritius—Mr. Meldrum.

RETARDED EGRESS

New Zealand—Lieut.-Col. Tupman, R.M.A., Lieut. Coke, R.N.
Brisbane—Capt. Morris, R.E., Lieut. Darwin, R.E., Mr. Peek.
Melbourne—Mr. Ellery and staff.
Sydney—Mr. Russell and staff.

INSTRUCTIONS TO OBSERVERS

The "Instructions issued by the International Conference on the Transit of Venus, 1882," are recommended for general adoption. These instructions are, in a great measure, founded upon "Suggestions for a Draft of Instructions for the Observers," which the English Committee circulated for consideration in October, 1881. But as copies of the Instructions, issued by the International Conference, may not reach observers in the English colonies who may be willing and able to co-operate effectively, and as there are some additional explanations and cautions which the English Committee consider it desirable to give their observers, the following instructions have been issued. It is most earnestly hoped that all observers who are able to co-operate effectively in the observation of contacts will, whatever else they may observe, observe the *contacts as defined;* and that they will employ sufficient magnifying powers on their telescopes and use a field of view of moderate brightness. These are essentials, if their observations are to be combined with the results of the English expeditions.

1. It is most important that the apertures of the refractors used for the observations of the contacts should be nearly equal. The apertures of the telescopes available for the English expeditions are not generally larger than six inches; and it is therefore recommended that observers with larger apertures should stop them down to six inches, but not reduce them below that size. It is considered that perfect instruments of four inches aperture may give results sufficiently comparable with those made with the six-inch telescopes to allow all the observations to be combined in one common discussion; and it is hoped that observations with such instruments will be made. Observations with good instruments of smaller apertures than four inches will be exceedingly valuable for combination with others made with instruments of the same class, provided that powers of 100 to 150 can be employed on them. Observations of contact made with very *low powers* are useless for the objects in view. When reflectors are used, apertures should not be less than seven inches.

2. The observers are requested to furnish tests of the optical performances of their telescopes, such as—

(1) The appearances presented by the disc of a bright star when the eye-piece is pushed within and pulled without the focus.

(2) The power of the telescope to separate some well-known close double stars.

(3) Whether the observer was able to see the "rice grains" or "granulations" on the sun's disc on the day of the transit and if not, whether he is generally able to see them with the same instrument and a power of 150 on days of good definition.

3. The observers are recommended to employ a first-surface reflecting prism to diminish the sun's heat and danger to the observer's eye, and a compensated neutral-tint wedge *between the eye-piece and the eye.*

4. The eye-pieces recommended are the "negative," or a "Steinheil's simple achromatic positive eye-piece." When the latter is used, two pairs of very fine parallel wires should be placed on opposite sides of the field of view at distances corresponding to a second of arc apart. Such wires are useful in judging of the brightness of the field of view, and of the sufficiency of the optical power employed to subdivide a second of arc into tenths, and in estimating the angular separation of the limbs in descriptions of any phenomena which may be seen near the contact.

5. All attempts to observe the contacts with double-image eye-pieces are to be avoided.

6. The use of Dawes' solar eye-piece is not recommended. This eye-piece is exceedingly valuable for the examination of small detached portions of the solar disc; but the field of view is very limited, and, if clouds were passing, there would be practical difficulties in keeping the point of contact exactly in the centre of the field, whilst the effects of the stop would certainly be injurious to the contact observations near the edge of the field.

7. The magnifying power should be about 150, and, even if the definition is not good, this power should not be much reduced. It is essential that the observer should be able to subdivide a second of arc into tenths, and to do this a high power is necessary.

8. It is extremely desirable that all the observations of contact should be made in fields of view of nearly the same brightness, and the illumination should neither be one of extreme brightness, which greatly complicates the phenomena seen near the contacts from the increased effects of irradiation, nor one so faint that difficulties may be experienced in distinguishing changes in the illumination of the sun's limb near the point of contact, which can only be recognised by contrast. If pairs of very fine spider webs are placed at a distance corresponding to a second of arc in the focus of a positive eye-piece, they may be used for the determination of a suitable illumination of the field of view by observing at what part of the neutral-tint wedge the wires can just be seen with sufficient distinctness to allow the observer, without difficulty, to sub divide the interval between them into tenths; but in the application of the test the wedge must be shifted quickly, and the eye not allowed to strain itself in attempting to separate the wires, or a too dull field of view will be secured. The test is a delicate one to apply, and it is probably better to replace it in practice by the following:—When the sun is free from clouds, determine with what parts of the neutral-tint wedge the sun's limb can just be observed with comfort, and with what part of the wedge the limb can just be distinctly and clearly seen. A mean portion of the wedge between these extremes should be adopted as a standard field of brightness with a clear sun; and this degree of brightness, learnt by practice as a habit of the eye, should be adopted for the brightness of the field of view in the observation of the contacts.

9. The expressions "contact," "apparent contact," "actual contact," "real contact," and "true contact," appended to time records without any explanation of the sense in which the word "contact" is used, are liable to be misunderstood. Such expressions should not, therefore, be employed, unless a description of the particular kind of contact referred to is appended.

10. The phenomena seen, by most observers, near the time of contact, in a moderately bright field of view, are of a complex character, and extend over considerable intervals of time. It is therefore necessary to direct the attention of the observers to some *distinctive* phases which all those, who have sufficient optical means, should certainly see unless prevented by clouds. Subject to the remarks *a*, *b*, *c*, *d*, the times to be recorded near the internal contacts are as follows:—

At Ingress.—"The time of the last appearance of any well-marked and persistent discontinuity in the illumination of the apparent limb of the sun near the point of contact."

At Egress.—"The time of the first appearance of any well-marked and persistent discontinuity in the illumination of the apparent limb of the sun near the point of contact."

(*a*) The expression "*well-marked* and *persistent* discontinuity in the illumination of the apparent limb of the sun near the point of contact" is intended to guard observers against giving times for the contacts when there may be a *suspicion* only of some slight disturbance, haze, shadow, or interference phenomena. It is a point of primary importance that all the observers shall, as far as possible, observe the same kind of contact; and it is therefore desirable that the times recorded for contacts should refer to some marked discontinuity in the illumination of the sun's limb, about which there cannot be a doubt, and which may be supposed to be recognisable by all the observers.

(*b*.) If a pure geometrical contact, "contact géométrique sans déformation," is alone seen, this is the only time which can be given for the contact; but if haze, shadow, ligament, or black drop is seen, then the last time, when any marked discontinuity in the illumination of the sun's limb near the point of contact is distinctly recognised as *independent of mere atmospheric tremor*, is a time which should be recorded at ingress; and the first time at which such a marked discontinuity in the illumination is certain, is a time which should be recorded at egress. But if the haze, shadow, ligament, or black drop is ever seen as dark, or nearly as dark, as the outer edge of the planet, the time of greatest blackness, when it is last seen at ingress, or first seen at egress, as dark or nearly as dark as the outer edge of the planet, is also to be most carefully recorded; this phase appears to correspond most nearly to what is given by some observers as "contact géométrique sans déformation," and probably differs but little from what most observers would call "contact," if restricted to a single phase. Near the time of contact the attention of the observer should be directed to the parts of the sun's limb near the point of contact. The discontinuity of the illumination of the sun's limb near the point of contact will be recognised by the contrast between the illumination *at* and *on each side* of the point of contact.

(*c*) At ingress the contact can also be regarded as the time "when light is about to glimmer all across the dark space between the cusps." For so long as the sunlight has not "glimmered" across the dark space between the cusps, there must be "some well-marked and persistent discontinuity in the illumination of the sun's limb near the point of contact." In this definition the attention of the observer is directed to the light of the cusps which is encroaching upon the "dark space" between them, whilst in the definition adopted in these instructions his attention is directed to the disappearance of the dark space between the cusps which is being encroached upon by the light of the cusps. Great care is, however, required when the contact is thus regarded, that the glimmering of the light of the "auréole," "penumbra," or "sunlight refracted through the atmosphere of Venus," across the dark space between the cusps be not taken for the contact. The time thus recorded would be earlier than the contact required by about a minute of time. On the other hand, a time must not be given "when sunlight is distinctly recognised" between the limbs without any direct reference to the time when the dark space between the cusps was last recognised.

(*d*) The observer should clearly and distinctly indicate the times which, in his opinion, correspond most nearly to the contacts as defined above. But in cases where he has any doubt about the second of time which ought to be given, on account of the gradual obliteration and restoration of the illumination of the sun's limb near the point of contact, or on account of any change in the degree of darkness in the haze seen, he may give two times, with a clear intimation of his inability to say which of the two corresponds most nearly to the time of contact; and such observations, if the limits of uncertainty are confined within a few seconds, will be amongst the most satisfactory observations which can be made. The observer must not be discouraged from giving the nearest second possible on account of the lingering character of the contact. The *change in the angular* separation of the limbs of Venus and the sun is only a tenth of a second of arc in about two seconds of time. It is with seconds of arc, and not seconds of time, that we are ultimately concerned; and one tenth of a second of arc is a very small quantity to be measured on the sun's limb. In the Transit of 1874, when, however, the change in the angular separation was much slower than in 1882, many observers were discouraged and disappointed at the degree of accuracy attainable, and the observations appear to have suffered from a feeling on the part of the observers that such observations as they could make were worthless. This feeling should be carefully guarded against.

11. It is hoped that all the observers may be able to observe contacts as defined; but should an observer see a contact which, in his opinion, does not agree with the definition, he must record the time of contact, and describe the nature of the contact observed, with drawings to illustrate his meaning. It is desirable that an observer should record the times at which any *very distinctive* phenomena are first or last seen near the contacts. But the multiplication of *unnecessary* time records near the contacts is, in itself, a serious evil, and should be carefully guarded against; and, more particularly, records of time corresponding to "clear sunlight between the limbs of Venus and the Sun" are to be avoided after all touch, as shown by some recognisable disturbance of the illumination of the sun's limb near the point of contact, has ceased at Ingress between the limbs of Venus and the sun. When this touch has once ceased, all subsequent records of time, unless accompanied by direct measurements of the angular separation of the limbs at these times, afford no possible means of determining the angular separation of the centres of the sun and Venus. Such records are, therefore, of no direct value; but unless great care is taken they may be accepted as referring to contacts, and may thus lead to most serious error.

Attention to this point is more particularly necessary when observations of the contacts are picked up through clouds. If, therefore, times are recorded at "ingress" for "distinct band of light between the edge of Venus and the sun's limb" or "Venus well on the sun's disc," the observer must most distinctly state whether this time record is intended to mean that the haze, shadow, ligament, or black-drop was certainly seen within a few seconds, at most five, of the recorded time, or whether it is intended merely to state as an isolated fact that the contact was over at the time recorded. Time records of the first class are valuable, but those of the latter class are useless, and may be misleading.

12. If the limbs of Venus, at internal contact, as defined in 10, fall within the sun's disc, then the observer should give, as accurately as he is able, probably to seven or eight seconds, the time at which the limbs of Venus and those of the sun mentally completed would appear to touch. This observation must be a rough one; but it is desirable in the case indicated to give it as a check upon the principal phase observed.

13. External contacts should be observed. The value of the external and apparent contacts, which are referred to the "visible" or "apparent" limb of the sun, will greatly depend upon the extent to which uniformity in the instrumental equipments, and in the brightness of the fields of view, may have been secured.

14. It is desirable that all observers who have double-image micrometers should measure the cusps at egress, and the distances between the limbs of the sun and Venus after internal contact at ingress; but the eye-pieces should not be changed at ingress until there is a broad band of sunlight between the limbs of Venus and the sun. If an observer feels perfectly confident in his ability to change the double-image micrometer for an ordinary eye-piece and to focus properly, after making cusp measures, before internal contact at ingress, then such an observer may venture to make cusp measures at ingress; but it is most earnestly hoped that observers will not run any risk of losing the internal contact observations at ingress for the sake of these cusp measures. It is necessary, not only for the eye-pieces to be changed and the focus found, but that time should be allowed for the eye to accommodate itself to the new eye-piece before the internal contact takes place, or satisfactory observations of internal contact will not be made.

15. In all cases the recorded times should be those taken directly from the chronometer or clock used.

16. The maker's name and number of the chronometer or clock used should be given.

17. The errors of the chronometers and clocks should be given for a few days before and after the transit, and a clear statement made of how these errors have been determined. Chronometers should be compared, whenever possible, [before and after the transit with some standard clock.

18. The greatest care should be taken to insure the accuracy of the entries of times from the clocks and chronometers used in the contact observations, and unusual care is required in the verification of the *minutes* and the *half-minutes*. In most astronomical observations, if the seconds are recorded correctly,

the minutes can be supplied with perfect certainty by calculation; but in observations of a transit of Venus the contacts from apparent contact to the "last appearance of any marked "disturbance of the illumination" may, in a moderately bright field, extend over more than a minute of time; and if any misconception of the kind of contact which has been observed should be possible from ambiguity in the description given by the observer, then a serious error may be introduced into the discussion of the results from the adoption of a wrong minute and wrong kind of contact for this observation. In the use of chronometers mistakes of half a minute have occasionally been made by taking the "arrow end" instead of the "*longer* end" of the seconds hand.

In all cases, therefore, such precautions should be taken to verify the minutes and half-minutes that errors of entry can be asserted to be impossible.

19. Approximate latitudes and longitudes of the station, and the authorities from which they are derived, should in all cases be given, together with the local names of the station.

20. The position of the observer should be permanently marked, and, if possible, referred to three or more surrounding natural objects, as mountains, so that the position can be recovered if the mark should be accidentally destroyed.

21. In cases where the errors of the chronometers or clocks and the geographical position of the observers are independently determined, the observations upon which these determinations rest should be given.

22. The descriptions of the contacts which correspond to the time records should be written out by each observer, and entered in an indelible form, before any discussion or comparison of the observations with those made by any other observer has been made. On no account is a written figure to be altered. On no account is a new figure to be written upon an old one. Any correction is to be written on another line, and attested by the signature of the observer.

23. Copies of these observations, authenticated by the signature of the observer, with the necessary materials for the determination of clock-errors, longitudes, and latitudes, should be forwarded by the next or following mail to the Committee at the Royal Society, Burlington House, London. In the case of the Government expeditions, the original documents must be placed in the hands of the official in charge of the Treasury chest at the station, by whom the originals will be retained until the Committee have acknowledged the receipt of the copies and forwarded instructions for the despatch of the originals.

24. Practice with the artificial models of the transit will be useful to observers as a preparation for the slowness with which changes in the appearances presented near the internal contacts take place. But the exact phases presented in the real transit cannot at present be reproduced in the models, and, unless care is taken, model practice may do more harm than good in leading observers to expect a definite succession of phenomena near the internal contacts which they may be unable to recognise in the actual transit. The complicated phenomena presented near the internal contacts are, no doubt, chiefly due to diffractional irradiation; but in the case of the models we have the sun and Venus bounded by hard edges. The diffraction phenomena beyond the geometrical boundary of the artificial sun, and the interference phenomena between the limbs of the sun and Venus, are continually changing as the disc, which represents Venus, approaches nearer and nearer the hard edge which represents the geometrical boundary of the sun's disc. These conditions introduce complications into the phenomena seen with the model which have nothing exactly corresponding to them in the real transit; whilst, on the other hand, the presence of the partial illumination of the atmosphere of Venus introduces difficulties in the observation of the real transit which have nothing exactly corresponding to them in the models in ordinary use.

ATOMIC WEIGHTS[1]

SEVEN years after the publication of the first volume of Dalton's "New System of Chemical Philosophy," and therefore at a time when the data from which atomic weights could be deduced were few and inaccurate, Prout promulgated the hypothesis that the atomic weights of all the elements are multiples of that of hydrogen.

This hypothesis was soon shown to be without foundation in fact, but in the modified form given to it by Dumas—viz. the atomic weights of all the elements are whole, half, or quarter multiples of that of hydrogen—it found very considerable acceptance among chemists, although it was strongly opposed by many.

In 1860 Stas published the results of very carefully-made determinations of the atomic weights of nitrogen, chlorine, sulphur, potassium, sodium, lead, and silver. Stas concluded from these results that Prout's hypothesis is purely imaginary; that each elementary substance is a distinct entity, and exhibits no simple mass relations with other elements.

Marignac criticised the numbers obtained by Stas, objecting that unless an atomic weight is determined by wholly different series of experiments it cannot be accepted as final, and making the somewhat astonishing statement that possibly the composition of a given compound is not altogether invariable. The reply of Stas appeared in the form of his famous "Nouvelles recherches sur les lois des proportions chimiques, sur les poids atomiques et leur rapports mutuels," wherein the fixity of composition of many compounds was firmly established, and numbers were deduced, from widely different and most carefully conducted series of experiments, for the atomic weights of silver, iodine, bromine, chlorine, sulphur, nitrogen, lithium, potassium, sodium, and lead, which numbers appeared finally to negative the hypothesis of Prout, even in the form given to it by Dumas.

The experimental work of Stas has been accepted as unimpeachable by every chemist. The "Nouvelles recherches" is a classical work. But in 1878 Dumas showed that pure silver, prepared by the method adopted by Stas, gave up weighable quantities of oxygen when heated in vacuo. The numbers given by Stas as the atomic weights of the elements enumerated above may therefore not represent the true atomic weights of these elements. The importance of the discovery made by Dumas is emphasised when we know that the atomic weight of silver is a fundamental number, on which most of the other atomic weights determined by Stas depend.

In 1872, Crookes communicated to the Royal Society the results of an extremely careful determination of the atomic weight of thallium; the mean number obtained, 203·642, was regarded by Crookes as strongly against Prout's hypothesis.

Recent work, physical as well as chemical, has again caused attention to be turned to the hypothesis which would regard the elements as forms of one kind of matter.

The necessity for a revision of many atomic weights has impressed itself on chemists; and several very careful revisions, notably that of the atomic weight of antimony by Cooke, and of aluminium by Mallet, have recently been made. But in addition to these new data there exist many determinations, which, if properly collected and digested, would be of much importance. Prof. Clarke has done this most admirable service to science.

"Atomic Weight Determinations; a Digest of Investigations published since 1814," by Prof. G. T. Becker, has already appeared as Part iv. of the Smithsonian *Constants of Nature*; Prof. Clarke's *Recalculation* completes the *Digest*; together these form a contribution to chemical science of the first importance.

The ratio between the atomic weights of oxygen and hydrogen is that first discussed. Each series of experiments is considered separately; the mean value is found and the probable error of this mean is assigned by the method of least squares. Those elements, the atomic weights of which have been most carefully determined, viz. silver, chlorine, bromine, iodine, potassium, sodium, and sulphur, are next considered.

The discussion of atomic weights involves many chemi-

---

[1] "The Constants of Nature. Part V. A Recalculation of the Atomic Weights." By Frank Wigglesworth Clarke, S.B., Professor of Chemistry and Physics in the University of Cincinnati. (Washington: Smithsonian Institution, 1882.)

cal considerations: more or less weight must be given to different results on other than purely mathematical grounds; hence identical final results would not always be arrived at by different calculators starting from the same experimental data. Inasmuch as "the atomic weight of each element involves the probable error of all the other elements to which it is directly or indirectly referred," it may happen that the probable error attaching to an atomic weight determination is large, although the experimental data are extremely accurate. Thus, Crookes, by very accurate experiments, found the atomic weight of thallium to be 203·642; but this number supposes that $NO_3 = 61·889$; the value to be now assigned to the atomic weight of thallium depends on the accuracy with which the atomic weights of oxygen and nitrogen have been determined. The work of Crookes simply fixes, with great accuracy, the ratio between the equivalents of Tl and NO_3.

The most probable value for the atomic weight of oxygen is found to be 15·9633 (H = 1), with a probable error of ±·0035; any error which there may be in this determination is involved in the determinations of the atomic weights of most of those elements which come after oxygen. When the atomic weight is large, the error thus introduced may be considerable: thus if O = 15·9633 Ur = 238·482, but if O = 16·00 Ur = 239·03; difference = 0·548.

Some of the weighings involved in the calculations have been reduced to absolute standards, others are only uncorrected weighings in air; hence an error is sometimes introduced which cannot be eliminated.

The discovery of Dumas that silver prepared by the method of Stas, occludes weighable quantities of oxygen, has been already referred to; in four experiments Dumas found that 1 kilogram of silver occluded 82, 226, 140, and 249 milligrams of oxygen respectively; the largest of these numbers is taken by Prof. Clarke as "Dumas' correction." The effect of applying this correction is generally very slightly to lower the value of the atomic weight; the following table exhibits this effect in a few instances:—

	Uncorrected.	Corrected.	Difference.
Silver	107·923 ...	107·896 ...	− ·027
Chlorine ...	35·451 ...	35·478 ...	+ ·027
Bromine ...	79·751 ...	79·978 ...	+ ·027
Iodine	126·848 ...	126·875 ...	+ ·027
Potassium ...	39·109 ...	39·083 ...	− ·026
Sodium ...	23·051 ...	23·024 ...	− ·027

In the appendix is given a table containing the mean atomic weights (with probable errors attached) for all the elements, calculated from the most trustworthy data. It is shown that twenty-five out of the sixty-six elements considered have atomic weights the values of which differ by less than one-tenth of a unit from whole numbers, (H = 1) but many of those numbers which differ by more than this fraction involve any error which there may be in the determination of the value of the atomic weight of oxygen, multiplied many times. If the possible error in the value for oxygen be transferred to that for hydrogen, *i.e.* of O = 16, then it is shown that forty-four out of the sixty-six elements have atomic weights differing by less than one-tenth of a unit from whole numbers. Of these forty-four elements, twenty-six show plus, and thirteen minus variations from whole numbers. Those which exhibit minus variations are discussed in detail; the values for the atomic weights of seven of these have not been determined with any great accuracy; silver alone has a value which carries "very much weight against the hypothesis of Prout." Of those elements, twenty-six in number, the atomic weights of which exhibit plus variations (less than 0·1) from whole numbers, three—viz. Nb, Yt, and Ur—have values which have been very inaccurately determined; seven involve "Dumas' correction," the application of which will bring the values nearer whole numbers (Al, As, Ba, Cd, Li, P, and Na). Special sources of possible error are indicated in the discussion of the atomic weights of Al, Ca, F. Five, of the twenty-six elements, have atomic weights the values of which involve errors due to the possible occlusion of hydrogen by the metals when reduced from their compounds (Co, Fe, Ir, Ni, and W). In many other cases the variations from whole numbers are extremely small, *i.e.* much less than one-tenth of a unit. "In short in the majority of instances the errors may be diminished by corrections which are in all probability needed, and which we can easily point out."

Twenty-six elements have atomic weights the values of which vary more than one-tenth of a unit from whole numbers; of these twenty-six, three—viz. Cl, Rb, and Sr have values nearly half multiples of that of hydrogen; the atomic weights of nine—viz. Sr, Au, In, La, Rh, Ru, Si, Te, and Zr—have been very imperfectly determined; the atomic weights of Sb, Ce, Be, Yt, Pt, and Hg are discussed, and it is shown that the atomic weights of these elements *may* come within Prout's hypothesis; no criticism is offered on the atomic weights of Cr (52·129 ± ·025), Cu (63·318 ± ·011), Mo (95·747 ± ·051), and V (51·373 ± ·024).

The value to be assigned to iodine (126·848 ± ·022) depends on that for silver; at present iodine stands as an important exception to Prout's rule. Potassium presents a serious objection; but if "Dumas' correction" is applied K becomes 39·083 [O = 16]. Clarke concludes by saying that although he began his examination of atomic weights strongly prejudiced against Prout's hypothesis, the facts have obliged him to give it "a very respectful consideration." "All chemists must at least admit that the strife over it is not yet ended, and that its opponents cannot thus far claim a perfect victory."

The recalculation of atomic weights shows clearly to the chemist what experimental work ought now to be undertaken; revisions of the atomic weights of tellurium, silicon, boron, mercury, chromium, manganese, uranium, and gold are urgently called for. The "periodic law" requires that the atomic weight of tellurium should be smaller than that of iodine; although the mean number recently obtained by Wills is greater than 127, yet this number cannot be accepted as final. Several results brought out by Clarke have an important bearing on the "periodic law." In most of the tables of elements arranged in accordance with the law, didymium is placed before cerium and lanthanum; Clarke however shows that Di = 144·573 (± ·031); Ce = 140·424 (± ·017); and La = 138·526 (± ·03). Brauner, in his paper recently published in *Chem. Soc. Journal*, finds Di = 146·18 (mean of three results), and La = 139·58 (mean of two results). We may therefore conclude that La < Ce < Di. These elements then come in series 8; lanthanum in group III. giving the characteristic oxide La_2O_3, cerium in group IV. giving the oxide Ce_2O_4, and didymium in group V. with the oxide Di_2O_5, which oxide has been lately prepared and examined by Brauner (*Chem. Soc. Jnl. Trans.*, 1882, p. 68).

Prof. Clarke's work may be taken as a type of what is now so much wanted in chemistry: a careful collection and digestion of masses of facts. We seem to be forgetting that chemistry is a science, not a collection of facts. Every week adds fresh material to the heap; the science is in danger of being crushed beneath the load of details.

M. M. PATTISON MUIR

FIRE RISKS FROM ELECTRIC LIGHTING

A VERY strong and influential committee was recently formed by the Society of Electricians to draw up a series of rules and regulations not only for the guidance and instruction of those who have electric lighting apparatus installed on their premises, but for the reduction to a minimum of those risks of fire which are inherent to every system of artificial illumination. They point out that the chief dangers of every new application of electricity arise mainly from ignorance and inexperience on the part of those who supply and fit up the requisite plant.

The difficulties that beset the electrical engineer are chiefly internal and invisible, and they can only be effectually guarded against by "testing" or probing with electric currents. They depend chiefly on leakage, undue resistance in the conductor, and bad joints, which lead to waste of energy and the production of heat. These defects can only be detected by measuring, by means of special apparatus, the currents that are either ordinarily or for the purpose of testing, passed through the circuit. Bare or exposed conductors should always be within visual inspection, since the accidental falling on to, or the thoughtless placing of other conducting bodies upon such conductors might lead to "short circuiting" or the sudden generation of heat due to a powerful current of electricity in conductors too small to carry it.

The Committee point out that it cannot be too strongly urged that amongst the chief enemies to be guarded against are the presence of moisture and the use of "earth" as part of the circuit. Moisture leads to loss of current and to the destruction of the conductor by electrolytic corrosion, and the injudicious use of "earth" as a part of the circuit tends to magnify every other source of difficulty and danger.

The chief element of safety is the employment of skilled and experienced electricians to supervise the work.

The rules deal with the installation of the dynamo-machine, the fixture of the wires, the character of the lamps to be used, and the danger that accrues to the person.

To secure persons from danger inside buildings, it is essential so to arrange the conductors and fittings, that no one can be exposed to the shocks of alternating currents exceeding 60 volts; and that there should never be a difference of potential of more than 200 volts between any two points in the same room.

If the difference of potential within any house exceeds 200 volts, whether the source of electricity be external or internal, the house should be provided outside with a "switch," so arranged that the supply of electricity can be at once cut off.

The rules are very valuable, and should be obtained by all those who are contemplating the use of the electric light.

PROF. HAECKEL IN CEYLON[1]

II.

IN the July number of the *Deutsche Rundschau*, Prof. Haeckel gives a further account of his stay in Ceylon, a stay which his ardent enthusiasm and unwearied industry cannot fail to have made fruitful in results to the scientific world. The present series of papers being intended for magazine readers in general, is, as might be expected, altogether popular in tone. The Professor's researches and discoveries in support of the theory of Evolution, are only implied, not described in detail. His letter is written from the point of view of an intelligent and cultivated traveller, fully alive to the novelty and beauty of the scenes in which he found himself, and of a naturalist anxious to make the most of his very limited time to become familiar with the fauna and flora of that lovely island which Buddhist poets gracefully apostrophise as "a pearl on the brow of India." The energetic Professor was evidently a subject of much wonder to the languid Anglo-Indians and lazy Singhalese, as, in his white linen suit and "Sola" hat, he braved the mid-day sun and even occasionally the tropical rains, besides setting at nought the bites of countless leeches and the stings of mosquitoes and scorpions, and prosecuted his researches from morning till night. It is, however, to this constant bodily exercise and to his invariably temperate diet, that Prof. Haeckel ascribes his perfect health while on the island; but it is doubtful whether, as the body became enervated by the climate, such habits could be long sustained.

The first, and one of the most delightful excursions made by Prof. Haeckel in Ceylon, consisted in a visit to a Singhalese village called Kaduwella, situated on the left (southern) bank of the Kalany, about ten miles from Colombo. The party from Whist Bungalow, joined by their fellow countrymen residing at the neighbouring Elie House (formerly the residence of Sir J. Emerson Tennent) drove to the appointed place in the little one-horse carriages universal in Ceylon, which are drawn by brisk Burmese ponies, whose speed is superior to their staying powers, ten miles being quite sufficient to tire them out. Horses are rarely used in Ceylon, except in spring carriages, and are almost all imported from the Indian mainland, or from Australia; European horses cannot survive the climate. Bullocks may be said to be the only animals of draught or burden, and Prof. Haeckel mentions the long string of bullock carts, some single, some double, which are constantly met on the road; "the bullocks all belong to the class of the Zebu or humped oxen of India (*Bos indicus*), but there are many varieties; one of the smaller kinds is very swift and agile."[1]

Prof. Haeckel notes as among the most beautiful effects of the Ceylonese lowlands through which the road to Kaduwella lies, the middle place which they occupy between garden and forest, between cultivated and uncultivated nature." Surrounded by majestic trees, all overhung and overgrown with creepers and climbers, one might often imagine oneself in the midst of the wildest forest; but a little hut almost hidden beneath a bread-fruit tree, a dog or a pig issuing from the brushwood, children playing hide and seek behind the caladium leaves, serve to remind us that we are in fact in a Ceylonese garden. The real forest, on the other hand, which is closely adjacent, with its manifold juxtaposition of every variety of tropical trees, with its orchids, cloves, lilies, malvaceæ, and other lovely flowering plants, shows all the variety and apparent design of a costly pleasure garden. This singular mixture of nature and culture is visible also in the human accessories of these forest-gardens; for so great is the simplicity of the dwellings and the clothing of the Singhalese inhabiting them, that although the descendants of an old and cultivated race, there is little in their appearance to distinguish them from mere savages." Arrived at Kaduwella, after a halt and refreshment at the Rest-house (the government substitute for hotels, which are altogether wanting in Ceylon except in the chief towns), Prof. Haeckel made his first attempt to penetrate an Indian jungle, with what success his own words must tell: "The jungle is not, properly speaking, 'primeval forest,' forest, that is, untrodden by the foot of man (such are in Ceylon of small extent and rare occurrence); but it corresponds to our idea of such a forest in that it consists of a dense and impenetrable mass of mighty trees of all kinds, which have sprung up without regularity or any interference from man, and are surrounded and overgrown by a wilderness of creeping and climbing plants, of ferns, orchids, and other parasites, the interstices being so completely filled up with a motley mass of smaller weeds that it is quite impossible to disentangle the coil of tendrils so as to distinguish one species from the other. My first attempt to penetrate such a jungle as this was sufficient to convince me of the impossibility of the undertaking except with the aid of axe and fire. A hard hour's work brought me only a few steps into the thicket,

---

[1] Continued from p. 256.

[1] A pair of these little bullocks carry up about twenty bushels of rice to the hills, and bring down from fifty to sixty bushels of coffee to Colombo. (Sir J. E. Tennent's "Nat. Hist. of Ceylon," p. 52)

and then I was obliged to acknowledge myself vanquished and make good a retreat, stung by mosquitoes, bitten by ants, with torn clothes, and arms and legs bleeding from the thorns and prickles with which the climbing palm (*Calamus*), the climbing Hibiscus, the Euphorbia, and a multitude of other jungle plants repulse every attack made on their impenetrable labyrinth. But the attempt had not been made altogether in vain, for it enabled me to gain a very fair idea of the jungle as a whole, more especially of the magnificence of its trees and creepers, besides introducing me to many separate varieties of animal and vegetable life, which were of the highest interest; here I saw the magnificent *Gloriosa superba*, the poisonous climbing lily of Ceylon, with its red and amber flowers; the prickly *Hibiscus radiatus*, with large cup-shaped brimstone-coloured flowers, deepening to violet in the hollow; while round them fluttered gigantic black butterflies with blood-red spots on their tail-shaped wings, and chafers and dragon-flies flew past with a metallic gleam. But my delight reached its height when on this, my first attempt to penetrate a jungle in Ceylon, I came across the two most characteristic of its inhabitants from among the higher class of animals—parrots and apes. A flock of green parrots flew screeching from a lofty tree, as they became aware of the gun in my hand, and at the same moment a herd of great black apes sprang with a growling cry into the thicket. I did not succeed in getting a shot at either one or the other; they appeared to be too familiar with the look of a gun. I was consoled, however, by securing with my first shot a colossal lizard or iguana six feet long, of a kind held in much awe by the superstitious natives (*Hydrosaurus salvator*). The huge crocodile-like beast was sunning himself on the edge of a water-tank, and the shot hit him so precisely on the head as to kill him at once; had it struck any less vital part he would probably have dived into the water and disappeared; when seized, the iguana has the power of hitting so sharp a blow with its scaly tail as to cause a severe wound and even sometimes a broken limb."

We regret that want of space forbids us to quote entire Prof. Haeckel's account of a Buddhist temple built on the wooded heights above Kaduwella, and the scene of constant pilgrimages. It was constructed originally out of a natural grotto, the back part of the temple being composed of the bare rock, from which also is hewn the colossal figure of Buddha, which is invariable in all Buddhist temples. Almost as invariable is the adjoining Dagoba, a bell-shaped dome without any opening, containing a relic of Gotama. The size of the dagobas varies from that of a large church bell to the circumference of the dome of St. Peter's at Rome. Near the Dagoba is generally to be seen a large Bo-Ga, or sacred fig-tree (*Ficus religiosa*).

"These 'Buddha-trees' with their venerable stems, fantastic roots, and colossal crown of foliage form a prominent feature in the picturesque surroundings of the temples; their leaves, which are heart-shaped, with long stalks, quiver like our aspens."

The description given by Prof. Haeckel of the Royal Botanic Garden at Peradenia will be read with interest by all who value the efforts, whether of governments or of individuals, to encourage scientific knowledge by placing the means of gaining it within the reach of all. This admirable institution was founded sixty years ago on the site of an ancient royal residence, and placed under the direction of Dr. Gardner. His successor, Dr. Thwaites, the learned compiler of the first "Flora Ceylanica," laboured for thirty years to render the garden worthy of its extraordinary advantages of position and climate. On his retirement a few years ago, Dr. Henry Trimen was appointed director, and from him Prof. Haeckel received a pressing invitation, which all that he had heard and read of Peradenia urged him to accept.

Peradenia is now connected with Kandy, the original capital of Ceylon, by a railway, the first in the island. Prof. Haeckel notes by the way that railway travelling affords the greatest delight to the natives, many of whom make the journey up and down daily for the mere pleasure of the ride! It is the only indulgence on which they are willing to spend their money, and fortunately the line is a cheap one. The journey is of between four and five hours' duration, and the first half of it lies through low lands covered with swampy jungle, alternating with rice fields and swamp meadows. After that, the line begins to ascend, and a constant succession of beautiful mountain landscapes unfold themselves to the view. One of the most magnificent of these is afforded to the traveller at the point called the "Sensation Rock." "Here the line, after passing through several tunnels, runs under projecting cliffs at the edge of a precipice with a sheer descent of 1200 to 1400 feet. Roaring waterfalls from the rocky heights on the left are spanned by railway bridges, and, dashing downwards, are dissolved into spray before they reach the foot of the precipice; the sunshine striking them forms them into glittering rainbows. The green valley lying far below our feet is covered partly with jungle, partly with cultivated land scattered over with huts, gardens, and rice-fields, arranged in terraces. Towering above all other trees, rise the giant stems of the majestic Talipat palm, queen of all the palms of Ceylon (*Corypha umbraculifera*). Its perfectly straight white stem resembles a slender marble pillar, and often exceeds 100 feet in height. Each of the fan-shaped leaves which form its stately crown covers a half-circle sixteen feet in diameter; they, like every other part of the tree, are turned to manifold uses, being especially employed for thatching; they formerly provided the Singhalese with a substitute for paper, and are still used in that capacity. The old Puskola manuscripts of the Buddhist monasteries are all written with an iron style upon this "ola" paper, narrow strips of talipat leaves boiled and dried in the sun. The stately talipat palm blooms but once, usually between the fiftieth and eightieth year of its life; the pyramidal clusters of flowers crowning the summit of the palm, reach the length of thirty to forty feet, and are formed of millions of small yellow-white blossoms; when the seed-vessels ripen, the tree dies. By a fortunate chance it happened that an unusual number of talipat palms were in flower during my stay; I counted more than sixty between Rambukhana and Kadugannawa, and more than a hundred during the whole railway journey. Excursions were made from Colombo to witness the rare and beautiful sight."

The following extract gives Prof. Haeckel's first impression of the Botanic Garden of Peradenia:—

"The entrance to the Garden is through a noble avenue of india-rubber trees (*Ficus elastica*). The milky sap of this tree thickens into *caoutchouc*. Young plants of it are cultivated in heated rooms of our cold north, for the sake of the decorative beauty of their oval sap-green leaves: but while with us india-rubber plants of six or eight feet high, are esteemed a wonder, here in their native land they take rank with the noblest of forest trees, and would rival our oaks in size and strength. A huge crown of many thousand leaves proceeding from horizontal branches 40 to 50 feet long, covers the superficial area of a stately palace, and from the base of its powerful stem rises a network of roots, often between 100 feet and 200 feet in diameter, more than the height of the tree itself. This marvellous mass of roots rises on all sides and twists round the tree in such a manner, that the natives have given it the name of the "snake-tree."[1]

"Scarcely had I recovered from my astonishment at this

---

[1] "Like snakes in wild festoon
In famous wrestlings interlaced
A forest Laocoon."
(Hood's Poem of "The Elm Tree.")

wonderful avenue of snake trees, when my attention was arrested by a noble group of palms, including nearly all those indigenous to the island, and a number of foreign representatives of this noblest of tropical trees; all festooned with masses of flowering creepers, and adorned with graceful ferns growing at their base. Another similar, but larger and more beautiful group of palms stands at the further end of the avenue. Here the path divides and leads on the left to a little eminence, on which the director's bungalow stands. This charming residence is, like most of the villas of Ceylon, a low one-storied building, surrounded by a verandah, the projecting roof of which is supported by a row of white pillars." . . . The villa stands on the highest point of the garden, which covers an area of 150 acres, and overlooks the noble Mahawelli River, which encircles it on three sides. Its position and climate are unusually favourable for the cultivation of all the wonders of the Ceylon flora.

"In four days spent in Peradenia," says Prof. Haeckel, "I learnt more of the life and nature of the vegetable world than I should have acquired by as many months of close botanical study at home. I can never be grateful enough to my good friend Dr. Trimen for his hospitality and the rich stores of learning which he placed at my service; the days spent in his bungalow were among the most fruitful of my life.

"Another English botanist, Dr. Marshall Ward, was at Peradenia at the same time as myself; he had pursued his studies for the most part in Germany, and bore the official title of 'Royal Cryptogamist.' He had been sent here two years previously by the English government to study the coffee-leaf disease which for many years has raged with inceasing violence in the coffee-plantations of Ceylon, and has in great measure destroyed this valuable source of revenue to the island. Dr. Ward made many valuable observations and experiments on the natural history of the microscopic fungus, which contains the germ of the disease; but unfortunately he did not succeed in discovering any radical remedy for it. Instead, therefore, of receiving the gratitude due to him for his assiduous labours, he found himself violently taken to task by the press, and especially by the coffee planters. As if the hundreds of European naturalists engaged at the present time in investigating the nature and causes of similar plant epidemics should all be expected to discover a remedy for the disease they are studying! That this is seldom successfully done is a well established fact, and no axiom is more devoid of truth than that current in what are called 'cultivated circles,' that 'every disease has its cure.'

"It would lead me too far, and would weary my readers to no purpose were I to attempt a mere verbal description of the botanical paradise of Peradenia; even the drawings and water-colour sketches which I there made give a very inadequate idea of its beauties. Unlike most of our botanic gardens in Europe, the plants are not disposed in stiffly laid out beds, but are arranged with a regard to æsthetic effect, as well as to scientific classification. The principal groups of trees and the plants of kindred families are gracefully divided by smooth lawns of turf, and good paths lead from one to the other. In a more retired part of the park are the less attractive and more useful growths of both hemispheres, the seeds, fruit, and shoots of which are distributed among the gardeners and growers of the island. In this way the garden has been for many years of great practical utility as a centre of experiments and a garden of acclimatisation."

We must conclude our extracts with a suggestion from Prof. Haeckel which seems worthy of notice. He says:

"The singularly favourable climatic and topographical conditions of the Garden of Peradenia would seem to fit it for a wider sphere of scientific usefulness as a botanic station. In the same way that zoological students are now provided with invaluable means of assistance in the prosecution of their studies by the establishment of zoological stations on the sea-coast (at Naples, Roscoff, Brighton, Trieste, &c.) might young botanists in such a botanic station as Peradenia learn and accomplish as much in one year as they would in ten years under less favourable circumstances. Hitherto the tropical zone, the richest of all in materials for study, contains no such institution. If the English Government would establish and maintain a botanic station at Peradenia and a zoological station at Galle, she would add an important item to the services bestowed on science by her *Challenger* Expedition and other similar scientific undertakings; and she would once more put to shame those States of Continental Europe who can find no more useful or beneficial way of spending their money than in the manufacture of breech-loaders and cannon."

KŒNIG'S EXPERIMENTS IN ACOUSTICS[1]

II.

IN a preceding article it was recounted how Kœnig has applied the principle of the wave-siren to prove by direct experiment the influence which *phase* has upon the quality of a sound. The view taken by Kœnig that this difference may be completely explained by observing the difference in the form of the resultant waves was also briefly set forth. Two large diagrams were given which illustrated the matter very completely. A set of odd members only was taken from a harmonic series in which the amplitudes decreased in inverse ratio to the order of the harmonic; the series having for the ratios of its frequencies the numbers $1 : 3 : 5 : 7 : 9$, with the respective amplitudes $1 : \frac{1}{3} : \frac{1}{5} : \frac{1}{7} : \frac{1}{9}$. These were compounded together, firstly without any difference of phase, and secondly with a difference of phase of $\frac{1}{4}$ the wave-length. The resultant in one case showed well-rounded sinuosities, and in the other angular zigzags. In the first case the whole of the components had at their origin zero amplitudes, in the second they all, at the origin, had their individual amplitudes at maximum values. Kœnig found the result, when the curves were actually tried upon his wave-siren, to be that though the constituent tones in the two cases were identical in pitch and amplitude the resultant sound from the zig-zag curve was harsh and strident compared with that produced by the rounded sinuosities; thus clearly proving an influence due to difference of phase only.

We give in Fig. 4 the resultant curves found by Kœnig in four typical instances. The first line of curves (*a*) shows the resultants of a set of ten partial tones with regularly diminishing amplitudes, as compounded together, first with *no* difference of phase, then with differences of $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ respectively. The sounds corresponding to these combinations were found to be loudest and most forcible for difference of phase $=\frac{1}{4}$, and to be least forcible for $d=\frac{3}{4}$, the phases of 0 and $\frac{1}{2}$ having intermediate intensity.

Fig. 4 (*b*) illustrates the combination first mentioned above, for which the differences of phase $\frac{1}{4}$ and $\frac{3}{4}$ produced a strident tone as compared with 0 and $\frac{1}{2}$, which agreed in giving a smoother resultant sound.

In Fig. 4 (*c*), which represents a series of harmonic tones with amplitudes whose successive values diminish each time by $\frac{1}{2}$, the results agreed in general with those obtained from the same series when the amplitudes diminished less suddenly, the phases $\frac{1}{4}$ and $\frac{3}{4}$ corresponding respectively to the maximum and minimum of intensity.

In Fig. 4 (*d*), where again we deal with a series of odd harmonics only, there is a harsher and louder sound for $d=\frac{1}{4}$ and $d=\frac{3}{4}$ than for $d=0$ and $d=\frac{1}{2}$.

In order to carry out these researches more fully, Kœnig has constructed a very large and complete appa-

---

[1] Continued from p. 206.

ratus on the principle of the wave-siren. Its mode of operation will be best understood by reference to Fig. 5, taken by Dr. Kœnig's permission from his work, "Quelques Expériences d'Acoustique." Upon a strong stage about 4 feet high is mounted a series of 16 brass disks, cut at their edges into sinusoidal wave-forms, all fixed upon a common axis, and capable of being rotated by a band and treadle. The wave-forms cut against the contours of these 16 disks represent a harmonic series of 16 members of decreasing amplitude, there being just 16 times as many sinuosities on the largest as on the smallest disk. Against the edge of each of these wave-disks wind can be blown by a special mouth-piece in the form of a horizontally-placed slit connected by a tube to a powerful wind-chest mounted upon the stand of the instrument. We have, in fact, here sixteen simple wave-sirens of different pitch all combined together in such a manner that any one of them can be used separately. When the axis is rotated the wave-disks pass in front of the slits through which the wind is blown, and throw the issuing streams of air into vibration. Each wave-disk thus sets up a perfectly simple tone. We have therefore provided in this instrument a fundamental sound with its fifteen upper partial tones. It is clear that any desired combination can be made by opening the appropriate stops on the wind chest. In order to vary at will the *phase* in which these elementary tones are combined, a very ingenious arrangement is adopted. The brass tubes which terminate in the fifteen mouth-pieces are connected by flexible caoutchouc pipes to the wind-chest. The mouthpiece tubes are mounted upon a plate in such a way that they can slide up and down in curved slots concentric with the disks. By the aid of templates cut out in comb-fashion, and screwed to a lever handle, the mouth-pieces, or any set of them, can be displaced at will; thereby introducing any required difference of phase. Fig. 6 shows the way in which the fifteen mouth-piece slits are arranged with respect to the wave-disks; there being two series along two different radii, eight corresponding to the even members of the series, and seven to the odd members. They are set with the slits each opposite a summit or crest of its wave-disk, so that all the slots are closed simultaneously. This in Kœnig's nomenclature corresponds to a phase of $\frac{3}{4}$; the minimum condensations of all the individual air-waves occurring simultaneously.

Suppose now it is desired to change the phase in which the waves are compounded, and to make all the maximum condensations occur simultaneously (*i.e.* $d = \frac{1}{4}$): all that is necessary is to move the mouth-pieces of the odd series forward to the positions shown in Fig. 7, where all the slits are seen to be opposite hollows of the wave-disks. This is, of course, done by pushing up under the lower series of tubes a comb-like template which moves each through half its own wave-length.

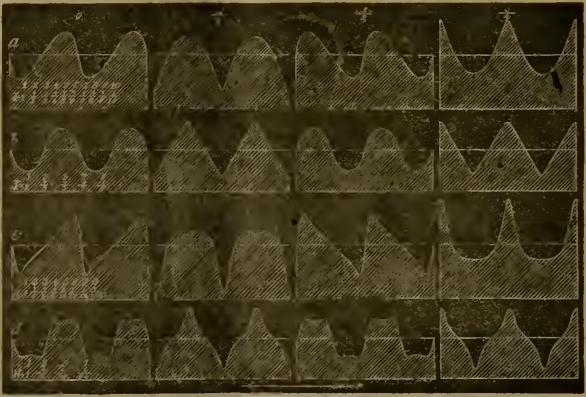


FIG. 4.—Curves resulting from the superposition of harmonic series in various phases.

The template that is used for causing the difference of phase to become zero, is shown in Fig. 8, attached to the lever-handle. Here the first, or fundamental slit, being always immovable, the fourth, eighth, and twelfth slits will not require to be moved, but the intermediate members will require shifting by $\frac{1}{4}$, $\frac{1}{2}$, or $\frac{3}{4}$ of their wave-length, according to their place in the series. When this set of positions is attained, the condensation is increasing simultaneously in all the sixteen waves, and reaches its mean value in all at the same moment.

The fourth method of placing the slits, so as to produce difference of phase $= \frac{1}{2}$ in the combination, is shown in Fig. 9.

Having thus described the peculiar arrangements for experimenting, we will briefly give Kœnig's principal results.

If first we take simply the fundamental and its octave together, the total resultant sound has the greatest intensity for $d = \frac{1}{4}$, and at the same time the whole character of the sound becomes somewhat more grave, as if the fundamental tone predominated more. The intensity is least when $d = \frac{3}{4}$. If, however, attention is concentrated on the octave-note while the phase is changed, the intensity of it appears to be about the same for $d = \frac{1}{4}$ and $d = \frac{3}{4}$, but weaker in all other positions.

The compound tones formed only of odd numbers of the harmonic series have always more power and brilliancy in tone for phase-differences of $\frac{1}{4}$ and $\frac{3}{4}$, than for 0 and $\frac{1}{2}$, but the quality for $\frac{1}{4}$ is always the same as that for $\frac{3}{4}$, and the quality for 0 is always the same as for $\frac{1}{2}$. This peculiary corresponds precisely to the peculiarity of the curves (see Fig. 4, *b* and *d*), in which the resultant wave-forms are correspondingly identical.

For compound tones corresponding to the whole series, odd and even, there is, in every case, minimum intensity, brilliancy, and stridence with $d = \frac{3}{4}$, and maximum when $d = \frac{1}{4}$; the phases 0 and $\frac{1}{2}$ being intermediate. A reference to Fig. 4, *a* and *b*, will here show that the maxima of intensity occur in those wave-forms which yield a sudden and brief maximum condensation. It is clear, also, that as the phase 0 and the phase $\frac{1}{2}$ are not identical, the action on the ear is not the same when a sudden condensation is produced and dies away gradually, as when a condensation gradually rises to its maximum and then suddenly falls off. It may be added, that no explanation of this very novel result has yet been advanced from a theoretical point of view.

Fig. 5.—Kœnig's Wave-disk Apparatus for synthetic researches on the quality of compound tones.

There only remains one small detail of interest to narrate. Observing that wave-forms in which the waves are obliquely asymmetrical—steeper on one side than on the other—are produced as the resultant of a whole series of compounded partial tones, it occurred to Kœnig to produce from a perfect and symmetrical sinusoidal wave-curve a complex sound, by the very simple device of turning the slit, through which the wind was blown against it, into an oblique position.

Fig. 6.—Positions of the slits in front of the wave-disks for combining the sounds with phase-difference $\frac{3}{4}$.

In Fig. 10 is drawn a simple symmetrical wave-form *eglnprtv*. If a series of these are passed in front of a vertical slit, such as *a b*, a perfectly simple tone, devoid of upper partials, is heard. But by inclining the slit, as at *a b'*, the same effect is produced as if the wave-form had been changed to the oblique outline *e' g' l' n' p' r' t' v'*, the slit remaining upright all the while. But this oblique form is precisely like that obtained as the resultant of a decreasing series of partial tones (see Fig. 4, *a*). If the slit is inclined in the same direction as the forward movement of rotation of the wave-disk, the quality produced is the same as if all the partial tones coincided at their

Fig. 7.—Position of the slits for phase-difference $\frac{1}{4}$.

origin, or with phase difference = 0. If the slit be inclined in the opposite direction the quality is that corresponding to phase-difference = ½. It is easy then to examine whether or not the effect of these differences of phase on the ear is the same, by merely inclining the slit forward or backward. Kœnig finds invariably a purer and more perfect sound with phase-difference = 0, and a more strident and nasal sound with phase-difference = ½. This result is so easy to verify that it will doubtless be tried by many experimenters. Indeed many of the researches with the wave-disks are so easily repeated without any special or expensive apparatus that they will surely win a place amongst the familiar experiments of acoustics. S. P. T.

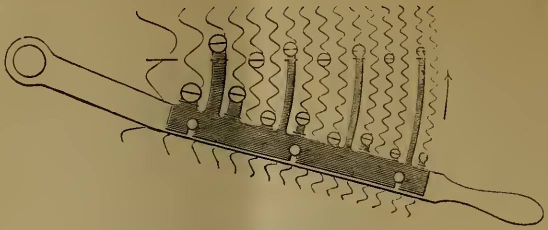


FIG. 8.—Position of the slits for phase-difference 0.

FIG. 9.—Position of the slits for phase-difference ½.

FIG. 10.—Effect of inclining the slit.

HONOUR TO M. PASTEUR

AT the *séance* of the Paris Academy of Sciences on the 26th ult., the President (M. Jamin) stated that a gathering of *savants*, friends, and admirers of M. Pasteur having resolved to present him with a medal commemorative of his remarkable discoveries, a committee had been appointed to watch the execution of it. On completion of the work, this committee, on June 25, repaired to M. Pasteur's house to present the medal, which is the design of M. Alphée Dubois, and happily recalls the physiognomy of its distinguished recipient. The meeting included MM. Dumas, Boussingault, Bouley, Jamin, Bertin, Tisserand, Davaine, and others. On this occasion M. Dumas delivered an address, in which he recalled the labours of M. Pasteur; and after receiving the medal, M. Pasteur made a few observations in reply. The two speeches have been, on the suggestion of M. Thenard, inserted in *Comptes rendus*, and we here reproduce them, in translation. M. Dumas said:—

"MY DEAR PASTEUR,—Forty years ago you entered this house as a student. From the first your teachers foresaw that you would be an honour to them; but none would have ventured to predict what brilliant services you were destined to render to science, to the country, and to the world.

"Your earliest labours banished occult forces for ever from the domain of chemistry, by explaining the anomalies of tartaric acid.

"Confirming the vital doctrine of alcoholic fermentation, you extended this doctrine of French chemistry to the most diverse fermentations, and you gave to the manufacture of vinegar, rules which industry now applies with thankfulness.

"Among these infinitely minute living things you discovered a third kingdom, to which those beings belong which, with all the prerogatives of animal life, do not need air to live, and which find the heat they require in the chemical decompositions they excite around themselves.

"The profound study of ferments gave you the complete explanation of alterations undergone by organic substances—wine, beer, fruits, animal matters of all kinds; you explained the preservative *rôle* of heat applied to their conservation, and you learned to regulate the effects of it according to the temperature necessary to cause the death of ferments. Ferments when dead produce ferments no more.

"It was thus that you were led to maintain throughout the extent of the organic kingdoms the fundamental principle according to which life is derived from life, and which rejects as a useless and unfounded supposition the doctrine of spontaneous generation.

"It is thus that, showing air to be the vehicle of the germs of most ferments, you learned to preserve without alteration the most putrescible matters, by keeping them from all contact with impure air.

"Applying this idea to the alterations, so often fatal, to which wounds and sores are liable when the patients inhabit a contaminated place, you learned to guard them from this danger by surrounding their limbs with filtered air, and your precepts, adopted by surgical practice, daily insure to it successes it knew not before, and give its operations a boldness of which our predecessors had no presentiment.

"Vaccination was a beneficent practice. You have discovered its theory and enlarged its applications. You have learned how to produce vaccine matter from a virus; how a fatal poison becomes a harmless preservative. Your researches on anthracoid disease, and the practical consequences from them, have rendered to agriculture a service of which all Europe feels the value. But the results already obtained, however brilliant, are nothing in comparison with the applications which may be anticipated from the doctrine to which they are due. You have furnished a sure basis to the doctrine of viruses by associating it with the theory of ferments; you have opened a new era for medicine by proving that every virus may have its vaccine-matter.

"Amid these admirable conquests of pure science, natural philosophy, and practice, we might forget that there is one part of the country where your name is pronounced with particular respect—the country once so fortunate, where the silkworm is cultivated. A malady which had spread terror among all the families of our southern mountains had destroyed the fine races they had produced with much care and wise selection. The ruin was complete. *Now*, thanks to your processes of scientific *grainage*, the cultivators have regained their security, and the country sees one of its sources of wealth reviving.

"My dear Pasteur, your life has only known successes. The scientific method, of which you make such certain use, owes you its finest triumphs. The Normal School is proud to count you among the number of its students; the Academy of Sciences is elated at your researches; France ranks you among her glories.

"At a time when, from all parts, testimonies of the public gratitude are arising towards you, the homage we come to offer you in name of your admirers and your friends, may seem to you worthy of special attention. It emanates from a spontaneous and universal sentiment, and it preserves for posterity the faithful image of your features.

"May you, my dear Pasteur, long enjoy your honour, and contemplate the fruits, ever richer and more numerous, of your labours. Science, agriculture, industry, humanity, will feel eternal gratitude to you, and your name will live in their annals among the most illustrious and the most venerated."

M. Pasteur replied as follows:—

"MY DEAR TEACHER, -It is forty years, indeed, since I had the good fortune to make your acquaintance, and since you taught me to love science and honour.

"I came from the provinces; after each of your lectures, I went out from the Sorbonne, transported, and often moved even to tears. From that time, your talent as professor, your immortal works, your noble character, have inspired me with an admiration which has only increased with the maturity of my mind.

"You must have divined my sentiments, my dear Teacher. There is not a single important circumstance of my life or of that of my family, circumstance happy or painful, which has found you absent, and which you have not, in some sort, blessed.

"And here you are still among the foremost in expression of these testimonies, excessive truly in my opinion, of the esteem of my teachers, who have become my friends.

"And what you have done for me you have done for all your students. It is one of the distinctive traits of your nature. Behind individuals you have always contemplated France and her greatness.

"What shall I do henceforth? Hitherto great eulogia had inflamed my ardour, and only inspired the idea of rendering myself worthy of them by new efforts; but those which you have addressed to me, in name of the Academy and of learned societies, truly overpower me."

NOTES

THE Council of the Society of Arts have elected C. W. Siemens, D.C.L., LL.D., F.R.S., as Chairman for the ensuing year.

IT has now been definitely decided to build a permanent observatory on Ben Nevis.

IT is announced that the Duke of Bedford has given 5000*l.* for the endowment of a lectureship in physical science at Balliol College, Oxford.

DR. GEORGE DICKIE, ex-Professor of Botany in the University of Aberdeen, died at Aberdeen on Saturday morning. The deceased, who was a native of Aberdeen, and was educated at Marischal College, was for some time in practice in the city as a doctor and dispensing chemist. His tastes, however, lay very markedly in the line of botanical research. He held the Botanical Chair in the Queen's College, Belfast, for a number of years, and on the fusion of King's College and Marischal College into one Aberdeen University he was appointed Professor of Botany. He discharged the duties for seventeen years, only resigning in 1877 on account of impaired health. Dr. Dickie had written numerous papers, and published some books connected with his favourite study, these including "A Handbook of Flora of Aberdeenshire," which was subsequently supplemented by a much larger volume, "The Botanist's Guide," published in 1860. His favourite department of botanical study was *Algæ*. On the return of the *Challenger* expedition he was, for the purposes of study, supplied with the *Algæ* collected during the cruise.

LET us draw the attention of local natural history societies to the prospectus of the forthcoming International Fisheries Exhibition. On some points these societies might be able to render material aid to the Commissioners, who, we believe, are desirous of enlisting their co-operation. Indeed, all of our readers interested in such an exhibition should procure copies of the prospectus by applying to the Secretary, 24, Haymarket, London, S.W. The Exhibition will cover a very wide field, and therefore appeals to a great variety of interests.

PROF. A. SMITH of the Swedish National Museum, who has been delegated as the representative of Sweden at the Fishery Exhibition in London next year, has commissioned Dr. A. Malm to prepare a collection of the sea fish species of the west coast of Sweden, to be forwarded at the expense of the museum. Dr. Malm will also arrange the collection which the Gothenburg Museum will exhibit, Mr. O. Dickson having offered to defray the expenses thereof. Mr. Dickson has been chosen as the "honorary correspondent" of Sweden at the exhibition.

THE *Sydney Morning Herald* justly animadverts in strong terms on the geography in some of the school books in common use in New South Wales, under the sanction of the government. These are published by a well-known Glasgow firm, and no attempt has been made to adapt them either to the conditions of the Southern Hemisphere, or to recent knowledge. The *Herald* gives some choice examples of the "facts" taught to the rising generation at the Antipodes. "At twelve o'clock," the book tells us, "in the day, when you go out to play, if you look at the part of the sky where the sun is shining, that part is called the south; then turn and look behind you, where the sun never comes, that is the north, it is opposite the south." Again, "the country you live in is Ireland; it is called an island because it has water all round it, and is not joined to any other country;" the *Herald* states, "and this has been taught to Australian children, at the expense of the public of New South Wales, for the last thirty or forty years." In a chapter headed "Australasia," there is the following passage:—"The name of Australasia or Southern Asia is given to a number of islands in the Indian and Southern Oceans. The largest of these is New Holland, which is nearly as extensive as the whole of Europe. Much of the greater part of New Holland is unknown to Europeans; but there are British settlements on the coast. It is inhabited by a race of savages who are among the lowest and most degraded that are to be found in the world." The moral seems to us to be that the Australians ought to compile their own school-books.

THE invertebrate portion of the collection of fossils made by the late Mr. Charles Moore, now in the Royal Literary and Scientific Institution of that city, is being classified and arranged by Messrs. R. Etheridge, jun., and R. Bullen Newton, of the British Museum. The vertebrates will afterwards be examined by Mr. Wm. Davies of the British Museum.

OUR contemporary, *L'Electricité*, in an able article on the progress of electrical science, remarks that in all the most striking of recent advances it is improvement rather than invention that comes to the front, and that no compromise or equivocation can deny justice to the real original discoverers. "Bell does not efface Reis in spite of the recent Chancery suit; Faure cannot destroy Planté; and Swan, Edison, and the others cannot suppress the anterior labours of Changy."

IT is proposed to establish a "German Botanical Society" for the whole of the "Vaterland," founded on, and an extension of, the already existing "Botanical Society for the Province of Brandenburg." A conference for the purpose of founding the new society is summoned to meet at Eisenach on September 16; the conveners including many of the most distinguished botanists from all parts of Germany.

THE most recent issue of the "Bulletin de la Fédération des Sociétés d'Horticulture de Belgique," published under the authority of the Belgian Minister of the Interior, contains the usual evidence of the activity of horticulture in that little kingdom, as well as the ninth annual issue of Prof. Morren's valuable "Correspondance Botanique."

AT the sixth anniversary meeting of the Sanitary Institute, Mr. E. C. Robins read a paper on the work of the Institute. After dealing with the objects of the institution, which are to awaken the conscience of the country generally to the importance of preventive measures in arresting the spread of disease, to acquire and impart information upon all matters connected with the public health, and to influence the laws which might be framed for the public good in connection with sanitary matters, the reader addressed himself to these things, which still remained to be performed. With respect to the examination conducted by the Institute, it might soon be necessary to consider the extent to which technical education should be required as a condition precedent to such examination if the standard of efficiency for the offices of local surveyors or inspector of public nuisance was to be permanently raised. He was happy to think that during the last six years science classes were being established throughout the country by the municipal authorities of various cities. Instances were then given by Mr. Robins of the disabilities under which sanitarians laboured. The influence of the institute might be also used in favour of the public, and especially of the humbler portion of it, by getting a revision of the Water Companies' Act, which had granted to them inquisitorial powers quite inconsistent with public purposes of a sanitary nature. Another and pressing want of the day was greater uniformity in the bye-laws governing the action of local authorities.

A MEMORIAL has been presented by the Council of the Society of Arts to the Secretary of State for India calling attention to the great and growing demand for the services of persons skilled in forest cultivation and analogous occupations, in India and the Colonies generally, and to the increasing desire on the part of land agents, land stewards, and bailiffs to acquaint themselves with the scientific and technical treatment of plantations, woods, and forests, as a means of fitting them for the more satisfactory management of landed estates in the United Kingdom. The memorialists believe that no suitable provision exists at any of our great centres of instruction in this country for the teaching of natural science in its special reference to forestry, nor for the scientific teaching of sylviculture in any of its branches; and are of opinion by grafting itinerating classes for observation of the practical method adopted in the regularly worked forests abroad on classes for scientific teaching at home, established in connection with such a school as already exists at Cooper's Hill, satisfactory means could be afforded of enabling students to obtain the requisite knowledge, both theoretical and practical, to qualify them for entering upon the duties appertaining to forest management, whether in India, our colonies, or elsewhere. They therefore express their earnest hope that steps may be taken by the Council to establish a department for the teaching of forestry in the Royal Engineering College at Cooper's Hill.

WE have received a "Catechism" of modern elementary chemistry, or solutions of questions set at examinations of the London University, for the last twenty years, by the Lecturer on Chemistry at Downside. The appearance of a book like this is a further indication of what we are drifting to in this country in regard to science teaching. The numerous examinations have created a method of study which will meet the examination with the least expenditure of labour on the part of the student. Numerous small books on different branches of science have appeared with this object, containing a mass of facts simply crammed into them, and hence have earned the very appropriate term "cram books." They serve to "get up the Exam.," and are of no further use, generally creating a dislike of the subject. The little book before us is scarcely one of these, but it is an examination helper more in the manner than the substance. It contains over 400 questions that have been actually set, with answers appended, and will undoubtedly be useful in preparing for the matriculation and other examinations. It is intended to be used as an aid to a text-book, and as such is to be commended.

M. DELAPORTE, who has been exploring the celebrated remains of Cambodia on behalf of the French Government, propounds the idea—novel, we believe—that the remains at Angkor and elsewhere are due neither to Buddhism nor Serpent-worship, but were born of Brahminism. He finds figures and emblems of Siva, Vishnu, Rama, and other Brahminic gods and heroes everywhere. M. Delaporte has brought home numerous photographs, mouldings, &c., and the details of his discoveries, on which his new theory is based, will be anxiously looked for by archæologists. A brief note on the subject will be found in the *Bulletin* of the Society for Encouraging National Industry (May).

CONSIDERABLE consternation has been caused by the appearance of the Phylloxera at several points in the Canton of Neuchatel and Geneva.

IN order to secure the greater purity in the atmosphere of the St. Gothard Tunnel, an attempt is to be made to propel the locomotives by electricity. Experiments, for which the sum of 180,000 francs is set apart, are now being made at Berne with this object.

AN earthquake shock lasting four seconds was felt on Monday morning at half-past four o'clock at Laibach and Trieste. Another shock, lasting longer, was felt at nine o'clock. A smart earthquake shock, accompanied by subterranean thunder, was felt at Ardon, Canton Valais, on Tuesday, last week. A slight shock was felt at Geneva on Monday.

THE seven aëronautical ascents arranged for July 14 were made at Paris at 4 o'clock as contemplated. But it was impossible to make any of the scientific experiments which had been prepared, owing to the violence of the wind. One of the balloons exploded at 2000 feet, and the aëronauts were precipitated to the ground with terrific velocity, happily without any loss of life or injury of consequence. They were saved by a miracle, their car having been suspended in a gap between two houses. The catastrophe was produced by their imprudence, having placed their canvass in a net which was not quite large enough. The inferior part of the canvass being left unprotected exploded when it was filled by the expansion of the gas. This is a warning to aëronauts to place the right balloon in the right netting.

THE *Journal Officiel* publishes a table giving the exact number of public teachers in France; there are 32,463 females and 49,201 males. The salary of the largest number of them varies from 24*l.* to 100*l.*, only 198 females and 673 males having a salary of 100*l.* and upwards a year. Most of them receive pay of about 1*l.* per week. Under the present system their salaries involve an expense of little less than 3,000,000 sterling, and the Minister of Public Instruction refuses to propose any further increase under this head.

THE Belgian Academy offers a prize of 3000 francs for the best study of the subject of destruction of fishes by pollution of rivers. Four topics are specified—(1) What are the matters special to the principal industries, which, mixing with the water of small rivers, render them incompatible with the existence of fishes, and unfit for public supply, and for use by cattle? (2) A list of the rivers of Belgium, which are now "depopulated" by this state of things, with indication of the industries special to each of these rivers, and list of the edible fish that lived in them prior to the existence of those works. (3) Investigation and indication of practical means of purifying the waters at issue from the works, to render them compatible with the life of fishes without compromising the industry, combining the resources which may be offered by construction of basins of decantation, filtering, and the use of chemical agents. (4) Separate experiments on the matters which in each special industry cause the death of fishes, and on the degree of resistance of each edible fish to destruction. Memoirs are to be sent in before October 1, 1884.

AN illustrated treatise on Coal-tar Distillation, by Prof. Lunge of Zurich, and an essay on the Noctuidæ of North America, by Mr. Grote, with coloured illustrations, will be the next contributions, respectively to technical science and natural history, issued by Mr. Van Voorst.

THE additions to the Zoological Society's Gardens during the past week include a Tricoloured Lory (*Lorius tricolor*) from the Malay Archipelago, presented by Mr. H. Harraden; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Mr. G. W. Drabble; sixty-one Restless Cavies (*Cavia caprera*), British, presented by H.R.H. the Prince of Wales, K.G.; a Puff Adder (*Vipera arietans*) from South Africa, presented by Capt. Owen; a Helodcrme Lizard (*Heloderma horridum*) from Mexico, presented by Sir John Lubbock, Bart., F.Z.S.; a Littoral Callichthys Fish (*Callichthys littoralis*) from Demerara, presented by Mr. George Little; a Bonnet Monkey (*Macacus radiatus*), a Macaque Monkey (*Macacus cynomolgus*) from India, a Levaillant's Cynictis (*Cynictis penicillata*) from West Africa, a Great Eagle Owl (*Bubo maximus*), European, deposited; a Black-fronted Teetee (*Callithrix nigrifrons*) from Brazil, a Black-faced Ibis (*Theristicus caudatus*) from South America, a Cedar Bird (*Ampelis cedrorum*), six Yellow-headed Troupials (*Xanthrocephalus icterocephalus*) from North America, a Kolb's Vulture (*Gyps kolbii*), a Sociable Vulture (*Vultur auricularis*) from Africa, two Ceylonese Hanging Parrakeets (*Loriculus asiaticus*) from Ceylon, an Annulated Snake (*Leptodira annulata*) from Panama, purchased; a Turquosine Grass Parrakeet (*Euphema pulchella*), a Geoffroy's Dove (*Peristera geoffroii*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

DAYLIGHT OBSERVATIONS OF WELLS' COMET.—At the Dudley Observatory, Albany, this comet was observed on the meridian as early as June 5, just before noon, and again on June 11 and 12. The aperture of the object-glass of the transit-circle is 8 inches, the focal length of the telescope 10 feet. A detailed description, with engraving of the instrument with which these notable observations were made, will be found in vol. i. ot the *Annals* of the Dudley Observatory. On June 5 the comet was not perceived until forty seconds after transit, and was observed with difficulty on a single wire, but the positions obtained on the subsequent dates were considered very satisfactory. The true nucleus was seen at the observation of June 11, made about sixteen hours after the perihelion passage, and the estimated diameter of the disc was 0″·75. The nebulosity of the coma was uniform and faint about 10″ in diameter. It is stated that "while the nucleus was observed for position, the coma was scarcely noticed at all." The atmospheric conditions on this day were such as are well known to conduce to easy vision of objects in daylight. "The sky was sparsely covered with cumulus clouds, while the intermediate clear spaces were exceedingly transparent." On June 12 the nebulosity had increased in brightness, but the image was very unsteady, and "either for that reason, or because of the increased brightness of the nebulous screen, the nucleus proper could not be seen." The very favourable observation on the preceding day gave the following apparent position of the comet:—

	M.T. at Albany.		R.A.		Decl.
	h. m. s.		h. m. s.		° ′ ″
June 11, at	0 1 21·4	...	5 21 3·91	...	+19 9 17·6

This place agrees closely with that deduced from a parabolic orbit calculated by Mr. Wells, which will not be materially improved, without a discussion of the entire series of observations. The elements of this orbit are:—

Perihelion passage, June 10·53006 Greenwich M.T.

	° ′ ″	
Longitude of perihelion...	53 55 46·4	M.E. 1882·0
„ ascending node ...	204 56 16·8	
Inclination	73 48 32·3	
Logarithm of perihelion distance ...	8·7837199	

Motion—direct.

We are not aware that any complete observation of a comet on the meridian at noonday has been made since the year 1744. The grand comet in the early part of that year, first remarked by Klinkenberg at Harlem on December 9, 1743, attained an extraordinary degree of brilliancy towards the end of February. We find Bliss writing on February 12 (o.s.) to Lord Macclesfield, who had fitted up an observatory at Shirburn Castle, thus: "The comet appeared so very bright last night, equalling the light of Venus, that Dr. Bradley agrees that it may be seen on the meridian, and being engaged himself, has desired me to request your lordship to try to observe it. The elements which he left at Shirburn appear, to our last night's and former observations, to give the place true within 2′ of longitude and latitude." As a matter of fact the comet was observed on the meridian near noon, at Shirburn on the 28th and 29th of February, and at Greenwich on the 29th: these observations will be found reduced in Mr. Hind's paper on the comet of 1744 (*Astron. Nach.* vol. xxvii.)

Mr. Lewis Boss, the director of the Dudley Observatory, is to be congratulated on his success in the case of the comet of the present year. Excepting the days of observation, none of the remaining dates from June 5 to June 18 were clear enough at the comet's meridian passage: otherwise it is evident that Mr. Boss would have secured a perfectly unique series of positions.

GEOGRAPHICAL NOTES

COREA has at last followed the example of China and Japan, and cautiously opened a door or two to the outside "barbarian." From time immemorial Corea has been hemmed in by exclusiveness, and shares with Tibet the honour of being among the least-known countries in the world. Now, however, that both England and the United States have persuaded the Coreans to throw open four of their ports to commerce, we hope that our ignorance of an interesting land will soon be dispelled. Corea is almost half the size of France, and its population is variously estimated at from nine to fifteen millions. M. Elisée Réclus, in his "Geographie Universelle," compares the peninsula to Italy. Like Italy, it has a mountain chain running down the centre of the country, and giving off lateral valleys; as in the Apennines, the gentlest slopes and most fertile valleys are in the west, while the east is more precipitous and barren. As with Italy, Corea has in the north-west an Alpine mass, which guards her from intrusion there, though the mass does not really cover all the boundary. Of the geology we know but little, though many valuable minerals, including coal, are supposed to abound, and the country as a whole is capable of great development with proper guidance and suitable machinery. We trust before the inevitable Europeanising process is complete, that accurate information on the habits and customs, language, and ethnology of the Coreans will be obtained.

In presence of the numerous and contradictory hypotheses as to the former geological history of the delta of the Amu-daria, it is obvious that no satisfactory scientific result as to the change of beds in the basins of the Amu and Syr-daria can be arrived at, without a thorough geological study of the different deposits of the rivers of the great Aral depression. A first step in this direction was made by the Amu-daria expedition; and now M. Hedroitz publishes, in the *Izvestia*, a valuable paper, giving the result of his researches in the same direction. Of course, one year is too short a time for thoroughly exploring this wide field; and M. Hedroitz's researches, however safe his method, and valuable his observations on the geological structure of alluvial deposits of different rivers of the Aral depression, on the motion of sand-dunes in the steppe, &c , are not yet sufficiently advanced to bring the author to a few general conclusions from his observations. His paper contains more valuable data than ready-made theories, and we hope that he will again return to the Amu to continue his researches. But one of his conclusions is worthy of notice. He does not admit that the Uzboy was a branch of the Amu-daria, as was admitted by the first explorers of this old bed. He supposes that there was a time (before the tenth century) when the Amu reached the Caspian, but by means of another bed which was situated south of the Sary-kamysh depression, leaving here the beds of "Amu-alluvium," which are seen in the lower parts of the Uzboy, but are missing in its upper parts. As to the Uzboy, it was but a temporary and irregular outflow of Lake Aral towards the Caspian, being rather a series of salt lakes and ponds, than a true river. Its name, Uz-boy (or "Uz-boyu," "along ponds"), would seem to confirm this hypothesis. The geological exploration would thus again call in question our established theories as to the former aspect af the Aralo Caspian basin.

Hartleben, of Vienna, is issuing in parts a seventh German edition of Balbi's Universal Geography, under the editorship of Dr. Josef Chavanne, whose name is well-known as a scientific geographer and cartographer. Dr. Chavanne, to judge from the parts issued, is doing his work of editor conscientiously. In the mathematical and physical sections he seems to us to have brought the classical work abreast of the latest researches; and among the good points in the political geography are the statistics obtained at the recent censuses of 1881 and 1882, of all the leading countries of the world. While neither so detailed nor so picturesque as Réclus' "Geographie Universelle," the new edition of Balbi is perhaps more systematic and better adapted as a text-book, though it is published as a "house-book." With an exhaustive index the work will serve all the purposes of a succinct gazetteer.

The leading article in *Petermann's Mittheilungen* for July is a long account of the unfortunate *Jeannette* expedition, with a map showing its drift from East Cape, north-west, to Bennett Island, and the route of the boats south-west to Lena mouth, after the loss of the vessel. The course of the expedition within two years was thus within very narrow limits, and the gains to science can be of comparatively small moment. A long letter from Dr. Emin-Bey describes his journey in the east of Bahr-el-Jebel, in March, April, and May of last year. Among the notes is a letter from Dr. Schweinfurth, describing the results of his journey in April and May this year, along the Nile above Siut, for the purpose of collecting data for his map of the Nile valley; he gives some notes on the geology of the region.

The following extract from a letter from Mr. W. Thomas, Meteorological Office Reporter at Scilly, to Mr. Robert H. Scott, F.R.S., Secretary to the Meteorological Council, has been sent us for publication:—"Scilly, July 14, 1882. I beg to inform you of a curious disturbance of the sea at 9 a.m. yesterday, July 13, about low water, the wind S.S.W. The water flowed rapidly up to 3 feet perpendicular, and then ebbed out again. It flowed and ebbed three times; the second and third time was not so high as the first. From the first to the last was about half an hour.

The *Bolletino* of the Italian Geographical Society for May and June contains a detailed account of the work of the expedition under Capt. Cecchi in Shoa, with a map.

The Danish Arctic Exploring Expedition under the command of Naval Lieut. Hovgaard, sailed on Tuesday on her expedition.

The Geological Society of Stockholm has despatched an expedition to Spitzbergen, having for its special object the increase of our knowledge of the vegetable palæontology of the island.

BAROMETERS

The subject is so old and well-worn that it is impossible to add anything new to it, still it is so large that there is no fear of its being exhausted by the few following notes. It will be going back quite far enough if we begin with Hook (*Phil. Trans.* i., 218, 1666), who invented the wheel barometer, and point out that *his* (1666) method consisted in using a mercury trough formed of two short open cylinders communicating near the bottom). Into one of these the lower end of the barometer tube was inserted while the float connected with the index rested on the mercury in the other. Derham (*Phil. Trans.* xx., 45, 1698), avoided the uncertainty caused by the float, cord, and index-bearings, and took his readings by means of a rod (terminating in a point) connected with the index by a rack and pinion. Gray (*Phil. Trans.* xx, 176, 1698) in the same year proposed the very method that is now in use for taking observations with the standard barometers, for he left the barometer tube free of all fittings and attachments, and read off the actual height of the mercurial column by means of a microscope (*sic*) sliding on a vertical scale. Fitzgerald (*Phil. Trans.* lii., 146, 1761) attached two movable indexes to the dial of the wheel barometer to show the highest and lowest points reached during any given period; and he also gave the float nearly the full range by having the upper part of the tube three inches in diameter, while the short upturned end was only half an inch diameter. In 1770 (*Phil. Trans.* lx., 74) he increased the range of the index by introducing a system of levers with arms of unequal length.

The earliest suggestion for increasing the sensitiveness of the barometer was made (1668) by Hook, who fixed over the mercury a narrow tube containing spirit. Descartes also proposed that same form of instrument which was made by Huyghens; but the uncertainty caused by the vapour-tension of the spirit rendered the readings so valueless that Huyghens (and this method was also claimed by De la Hire) connected the capillary tube with the shorter upturned end of the barometer, and thus did not interfere with the vacuum. Rowning employed the same principle, but bent the fine tube over, so that (though still parallel to) it was below the mercurial column; Hook's (*Phil. Trans.* xvi., 241, 1686) method of 1686 consisted in having enlargements at both surfaces of the mercury and another, open, over the capillary. Above the coloured spirit and water which came to a convenient height in the fine tube, he placed turpentine sufficient to partly fill the open enlargement. As the rise in the spirit-column was thus compensated (or nearly so) by the shortening of the turpentine column, it had no appreciable effect on the level of the mercury. The conical or pendant barometer of Amontons (1695) consists of a conical tube of very fine bore, containing the mercurial column, suspended with the wider end downwards. When the pressure of the air increases the mercury rises in the tube, but owing to the diminished diameter it occupies a greater length; when the pressure is less the column descends, until on reaching a wider part of the tube it is sufficiently shortened to restore equilibrium. Theoretically the range may be increased to any extent by having a tube of only very slight taper, but in order that the column may not break the bore must be so small that friction and capillarity render correct graduation impossible. Whiting (*Pogg. Ann.* cxvii., 656, 1862) proposed in place of that to use two tubes of different diameters joined together with, at lower surface of mercury, an ivory plate with a little glass bulb attached above it. In the horizontal barometer of Bernoulli and Cassini the longer range is obtained by enlarging the tube at the upper level of the mercury and replacing the cistern by a tube of fine bore bent at a right angle. In Sir Samuel Moreland's *diagonal* barometer the top part of the tube is bent more or less from the perpendicular. It is said to have been invented by Derham, as he refers to his "former communication about a crooked tube." The instrument at South Kensington bears date 1750, and was made by Watkins and Smith, London; that at Peel Park, Salford, is by T. Whitehurst, Derby, 1772; there is also one in the museum at King's College. Hicks (*Prov. Prot.* No. 740, 1862) proposed to increase the range by terminating the tube at the top in a coil. The *maximum* registering barometer of Traill is the same as the diagonal, but with the addition of a short steel rod in the tube above the mercury; his *minimum* is on the same principle as the horizontal barometer, but the bottom open tube forms a smaller angle than a right angle with the vertical tube. The steel rod is placed in this open tube above the mercury. Howson's (*Pat.* No. 1616, 1861) is on an entirely different principle, as in it the cistern is supported by the floating power of a sealed glass tube which is inserted in the mercurial column, and is attached to the bottom of the cistern. This was reproduced by Vidi (*Les Mondes*, iii., 25, 1863) two years later.

As the absence of air above the mercury renders the tubes very liable to fracture, from the bumping of the column against the top, when barometers are carried or moved, the means of rendering the instruments more or less portable has occupied the attention of several. Nairne long ago overcame this difficulty by making the lower half or two-thirds of the tube of very fine bore. Passemente (1758) adopted the expedient of twisting the middle of the tube so as to form two or three coils of a flattened spiral. Spry (*Phil. Trans.* lv., 83, 1765), who unfortunately gave no illustration, wrote, "The small bowl at the top with beads therein, render it far less liable to break by the mercury's ascent, the bowl giving it an immediate expanse from the column, and the beads counteracting in force as so many springs." Uzielli (*Deut. Chem. Ges. Ber.* v., 1055, 1872) makes a somewhat similar proposal: "Above 800 mm. a glass valve is inserted in the tube, so that by inclining the tube the mercury rises above the valve; then, on bringing the tube upright again, the air is above the valve and the valve is sealed by mercury."

Recorders.—In Fontana's arrangement the barometer tube and short open tube are cemented into elbows at either end of a short horizontal tube (in this there is a stopcock). A float on the surface of the mercury in the open tube transmits its motion to a small section of a horizontal cylinder about 700 mm. in diameter, and covered with paper. Every hour an impression is made on this paper by a steel point moved by a clock. Kreils used a siphon barometer, and connected the float with the shorter arm of an unequal lever. The longer end of the lever carried a pencil, which, being struck every five minutes by a hammer moved by a clock, made a dot on a sheet of paper fixed to a frame drawn horizontally in front of it. Negretti and Zambra attach the float by means of cords attached to a balance with unequal arms to a pencil fastened to a square collar. This collar moves freely up and down a vertical rod of square cross-section; the rod is near the vertical cylinder round which the paper is wrapped, and the same clockwork which causes the cylinder to revolve moves the rod (at regular intervals) so as to bring the point of the pencil against the paper. Keith (*Encyc. Metrop.* 1845) attaches the recorder to the float rigidly by means of a thin steel rod; but he obtains nearly the whole of the movement of the mercurial column in the open limb by attaching to the upper limb a horizontal tube of large diameter. He thus makes the movement of the upper surface of the mercury scarcely perceptible. Redier (Symons' *Met. Mag.* x., 33, 1875) connects one pole of a battery to the float, and the other pole to a metal point which is lowered at regular intervals to make contact. The same clockwork which lowers the point draws a pencil along (but not touching) the paper which is wrapped round a horizontal cylinder. At the instant at which electrical contact is made the pencil marks a dot on the paper; it is then drawn back, and remains at rest for a certain time, when the operation is repeated. By this arrangement the ratio between the movement of the pencil and that of the float can be increased to any extent without offering any resistance to the movements of the latter. The same principle is employed by Hough; but as his instrument is a complete meteorograph, the mechanical details are varied in order that the movements of the barometer may be recorded on the same paper as those of the other instruments. Theorell's is a very similar instrument; but, by means of type, the record is made in printed numerals. It is not easy to decide under what heading Russell's instrument should be described, but this seems its most appropriate place. The barometer tube is fixed, but the cistern (which is a small one) floats in a vessel of mercury. The pen is attached to a rectangular framework which is drawn backwards and forwards once a minute in front of the paper. On electrical contact being made between a lever attached to the cistern and the side of a wire triangle attached to the pen-frame, the pen is pressed against the paper, and thus the position of the cistern is recorded.

Photographic Recorders.—In Brooke's (1846) apparatus a lever with arms of very unequal length has its short arm attached to a float, which rests on the mercury in the lower end of a large syphon barometer. The long arm carries a screen with a small hole in it; through this hole the light from a lamp produces a mark on a sensitive paper which is wound round a vertical cylinder moved by clockwork. Ronalds (Brit. Assoc. Rep. 346, 1851), 1847, of whose apparatus in the South Kensington Museum the only part visible is the *case* which, for aught one knows, *may* contain nothing, made the surface of the mercury trace its own line without the intervention of a movable screen. A lamp is placed behind the barometer tube and a lens is so adjusted that the surface of the mercury may throw its image on a sheet of prepared paper or a daguerrotype plate, which is moved horizontally by clockwork. At the same time correction is made for temperature by means of the metal rods which support the cistern of the barometer. In the improved form (Rep. Met. Comm. Roy. Soc. 40, 1867) of the instrument the sensitive paper is wound on a cylinder driven by clockwork, and the time is recorded by a stop which intercepts the marking for four minutes every two hours. The temperature-compensating apparatus is attached to the vertical slit at the barometer, so that an alteration in the temperature is indicated by a variation in the base line on the sensitive paper.

Volpicelli (*Compt. rend.* lxx. 334, 1870; *Les Mondes*, xxii. 365, 1870) constructed a barometer of which the following are the main details:—The millimetre scale is on a sheet of glass, and is photographed with the barometric variations. A solution of alum is interposed between the lamp and the mercurial column to intercept the heat-rays. It is arranged to allow the barometer to be read off without moving any of its parts. The interior of the casing is freely ventilated, and the clock which moves the paper makes a mark every hour, so that the record is uninterrupted.

Balance Barometers.—The Steelyard barometer (Moreland) is one of the oldest forms of the above. The tube is suspended to the shorter arm, and is balanced by the longer arm, at the end of which is the pointer, which moves over a graduated arc. The cistern is but very little wider than the tube; thus when the atmospheric pressure increases, the pointer rises, and *vice versâ*. The static barometer (Magellan) is very similar, except that the balance has arms of equal length, and the tube is balanced by a weight; the pointer is attached under the beam, and the extremity of it moves to and fro along a horizontal scale. Wild, in his recording-barometer, uses a tube with an enlarged upper extremity, so that the variations in weight produced by the alterations in the pressure of the air may be considerable. A pencil at the end of the pointer, which is fixed below the beam, records on a horizontal cylinder. The balance has a bent beam, the arm from which the tube is suspended being horizontal, and the arm to which the counterpoise is rigidly attached descending obliquely. Secchi (1867) used a slightly-bent beam with arms of equal length; the pointer which descended from the beam terminated at its lower extremity in a hinge, to which was attached one end of the horizontal rod, which carried the recording-pencil; parallel motion was obtained by a rod to which the other end of the horizontal rod was hinged. The record was made on a flat descending sheet of paper. Brassart (1872) did not in any way alter the principle of the instrument, but arranged it in a slightly different manner, so as to render more compact the meteorograph of which it formed a part. Schreiber makes his instrument record on a vertical revolving cylinder by means of a pencil attached to a rod suspended from the other arm of the balance; this rod hangs free, and is hit by a hammer, moved by clockwork, at intervals of ten minutes.

O'Reilly's is a balance barometer, but not at all similar to the foregoing, as the cistern is fixed to the tube, and the instrument is inclined from the vertical, and suspended by knife edges. The variations in the length of the mercurial column cause it to incline more or less, the amplitude of movement showing itself on a graduated arc by means of an index.

Cantoni employs a balance, but he has the tube fixed, and suspends the cistern, which is a small one, from one arm of the beam, to which is attached (underneath it) a pointer. Cecci adopts the same principle, but traces the record on smoked glazed paper (wound round a horizontal cylinder) by means of a long pointer fixed over the beam. The floating barometer of McGwire (Irish Acad. *Trans.* iv. 141, 1791) is a balance barometer, as its weight is counterpoised, or nearly so, by the wooden ring attached to the bottom of the tube. A very similar instrument was patented by McNeill (Patent, No. 1733, 1861).

Cistern Arrangements.—Prins maintained that by the following arrangement he obtained a constant level in the cistern. The reservoir has a glass cover a little below its rim; this cover has a hole in the centre rather larger than the tube which passes through it, through this space the mercury rises and spreads more or less over the cover. In Gloukhoff's barometer the mercury in the cistern is forced by means of a screw to pass through a hole, and to cover a glass ring. Then the movable scale is lowered so as to make the steel end touch the surface of the mercury. Amagat proposed to adjust the level in the cistern by means of an iron or glass cylinder which was forced down by a screw. Poleni (1740) adjusted the level by the immersion of a screw. Austin (Roy. Irish Acad. *Trans.* iv., 99, 1791) kept the level of the mercury in the cistern constant by overflow from an aperture in the side into a bag underneath. Hamilton (Roy. Irish Acad. *Trans.* v., 95, 1792) fitted his barometer with an ivory cistern, the upper part of which was closed by a cork ring; this being porous allowed air to pass through, but retained the mercury. The cistern which is most used is that of Fortin; it is a short, wide, glass cylinder which is fixed by three pillars, the ends of which have screws passing through an upper and a lower brass plate, by means of which the necessary pressure can be applied to make it mercury-tight. At the bottom of the cistern is a leather bag, which is raised or lowered by an adjusting screw, so that the surface of the mercury may be brought into contact with an ivory point which forms the zero of the scale; this point is seen through the glass cistern. The cistern of Green's barometer, which is used by the United States Signal Service, is essentially the same as Fortin's. Negretti and Zambra (Patent, No. 238, 1861) patented the following. The cistern is screwed at the upper part to fittings near the bottom of the tube, so that by turning it round it will be raised until a cushion or pad placed at the bottom of the cistern is brought up against the open end of the tube. Alvergnat (*Rev. Hebd. d. Chim.* March 1870) proposed a very elementary form on the same principle. Paul de Lamanon ("Observations sur la Physique," xix., 3, 1782) in order to determine to what extent the expansion of the mercury influenced the height of the column, marked a zero point on the shorter limb of a siphon barometer. Gay-Lussac (*Ann. de Chim.* i., 113, 1816), who pointed out that, by having the tube of the same diameter at both surfaces of the mercury, correction for capillarity was unnecessary, also made his barometer portable by sealing the top of the shorter limb with the exception of a very fine hole. At the same time he made the lower portion of the longer tube and the bend of tube of sufficiently small diameter to keep the mercurial column from breaking. Bunten introduced a great improvement by inserting an air-trap in the barometer tube. This he effected by drawing off the lower extremity of the upper half of the tube to form a capillary; he then sealed the lower half of the tube to the shoulder of the contraction, so that any air accidentally entering the tube would collect round this shoulder and not break the continuity of the column or destroy the vacuum. Lefranc (*Pogg. Ann.* lxxiv, 462, 1849) objected to Bunten's tube as being very liable to fracture, and proposed to guard against the admission of air by drawing off the lower limb of the siphon to a capillary tube, and then fitting to this tube by means of a perforated cork a short tube which is, midway, contracted to a very small diameter. De Luc used the siphon barometer, but made the instrument portable by inserting in the shorter limb an ivory stop-cock which had a cork plug, but with a small ivory tube in the cork. Blondeau constructed a very similar instrument, but made it of iron, and took his readings by means of a float. Stevenson's is an iron siphon barometer provided with stop-cocks at both limbs, so that it can be easily charged or emptied. Bogen (Patent, No. 2532, 1877) patented the following barometer:—The long leg of the siphon is closed at one end, and is supplied with a glass stopper, with a fine hole through it, at the other. The tube is filled, the stopper is inserted, and, the hole through the stopper being closed by the finger, the tube is inverted and a portion of the mercury allowed to flow away to produce a vacuum. The short leg is of the same diameter, and is formed with a semicircular bend at one end, which is ground to receive the open end of the long limb. The short limb is then partly filled with mercury, the two parts are fitted together, and the tube is brought to a vertical position. The level is read off by the same method as that employed by Derham, but with screw in place of rack and pinion. It stands on a centre, so that by turning the instrument round it can be seen whether the column is vertical. Greiner (Dove's *Repert. d. Phys.* i., 31, 1837), 1835, drew the bend off to a capillary, which entered the bottom of the open limb of the siphon. A short distance from the bottom this tube is contracted, and when the barometer is to be moved a plug is pressed into this contraction. W. Symons (Patent, No. 813, 1863) proposed to have no contraction, but to make the plug close the capillary opening. Dorwin (Patent, No. 1386, 1862) suggested a siphon barometer with cistern and stopcock in place of open limb; the cistern to be covered with chamois leather, and the stopcock to have india-rubber connectors above and below. Bohn constructs his instrument with enlarged tubes at the two surfaces of the mercury; the lower one surmounted by a narrow tube for the purpose of filling, and the upper one by a stopcock to facilitate the operation.

JAS. T. BROWN

ON MONOSTROMA, A GENUS OF ALGÆ

NOW that so much time and thought are devoted to the study of the green algæ, Dr. Wittrock's elaborate Monograph of the genus Monostroma[1] will be found a most desirable addition to our knowledge of these plants. The following abstract of this very interesting work may therefore not be unacceptable to the reader.

In the Introduction Dr. Wittrock, who writes in Swedish, relates all that is known concerning the history of the formation of the genus, the discovery of the species, the changes which have taken place in the classification, and the works which treat of the subject.

The genus Monostroma was formerly included in Ulva. Kützing was the first who divided the species of Ulva into those which were formed of one layer of cells and those which consisted of two layers. The former he called Ulva, the latter Phycoseris. Thuret afterwards formed the species with one layer into the new genus Monostroma. According to his arrangement Monostroma is included in the second order Zoosporeæ, sub-order, 1, Chlorosporeæ.

Of the affinities of Monostroma it will be sufficient to say that, through the bladder-like form at an early period of growth of two species, *M. bullosum* and *M. Grevillei*, (the *Ulva lactuca* of Harvey), it approaches to Enteromorpha, from which it differs in acquiring, at a later period, an expanded leaf-like form, whereas Enteromorpha always retains its tubular character. But a more effective distinction is found in the structure of the frond, which shows a nearer affinity with Tetraspora (which belongs to the Palmellaceæ). The chief distinction between Monostroma and Tetraspora lies in the zoospores, which, in *M. bullosum*, are (as in the other Ulvaceæ) oval, with the smaller end somewhat drawn out into a kind of beak (rostrum), to which cilia are attached. In Tetraspora the zoospores are nearly round, without a rostrum, but with two long cilia fastened to the zoospores, which can only be distinguished by their lighter colour.

To Prasiola Monostroma is also near. From this it is distinguished by the position of the cells, which are here never arranged in quadratic or rectangular groups, and by the holdfast or root-organs.

The frond (thallus) in Monostroma, at least in mature specimens, is a flat, membranous expansion. In two of the species it is, when young, in the form of a bladder or closed bag, which soon splits

---

[1] Försok till en Monographi öfver Algslägtet Monostroma, af V. B. Wittrock. Upsala, 1865.

and spreads open. In some species the frond is more or less lobed and laciniated, the margins either undulated, entire, or jagged. The species also vary in the thinness or thickness of the frond. The colour is always greenish, passing sometimes from yellowish to white, and, in one species, is quite dark.

In the young state the frond always adheres to some object, such as stones, rocks, or other algæ, but in most species it becomes detached, and lies at the bottom of the sea.

As to the internal structure of the frond, it is, on the whole, very thin, and the principal part is formed of a single layer of cells, which lie in the same plane. It is provided with a more or less abundant intercellular substance, and is held together by a cuticle, which incloses the whole frond.

The lower part of the frond, when attached to some object, has a more compound structure. The cells, as regards their form, situation, and other particulars, are more developed. In mature specimens of all the species yet examined, except *M. bullosum*, they are often of a lengthened club-shaped form, and lie with their thickened ends side by side, while the smaller ends wind about each other, and sometimes almost interlace. The cells are, moreover, of larger size than those in the upper part of the frond, so that the lower part of the frond is much thicker than the upper. In some cases other cells, resembling those in the upper part of the frond, are mixed with the club-shaped cells. From a transverse section of this part of the frond it would appear to be formed of two or even three layers of cells, of which only one is single, namely, that which is formed of the thickened ends of the cells; the other consists of their thin ends and of smaller cells. Somewhat different arrangements of the cells of the lower part of the frond are noticed in the description of species.

It is, therefore, the upper part of the frond only which is monostromatic. The cells in this part vary in form; some are rounded and have rather prominent angles, others are angular, with the angles sometimes rounded off, but occasionally quite sharp. Their longest axis is sometimes at right angles with the surface, at others it is horizontal. As to the position of the cells with regard to each other, in some species this is irregular, without any special order; in others the cells are grouped with more regularity two and two, three and three, or four and four together. They are separated more or less by the intercellular substance. The species which give the best examples of this kind of grouping are *M. bullosum*, *M. laceratum*, and *M. quaternarium*.

The substantial part of the frond consists of an inclosing membrane and its contents. The membrane, which is a true cellulose membrane, is, in mature examples, of most of the species very thin, and quite hyaline, therefore very difficult to detect. The most important part of the cell contents are the chlorophyll-bodies which are coloured by chlorophyll. In some species they fill the cells entirely and naturally take their form; in others they fill only half or even a less portion of the cells, and lie like a band across the cells parallel to the surface of the frond.

Within the chlorophyll-bodies are found abundantly round grains of starch; except for these the contents of the upper part of the fronds are tolerably homogeneous.

No nucleus (*cellulkärna*) has as yet been observed with certainty. In the monostromatic parts of *M. Grevillei* there are often seen, about the centre of the cells, almost circular light spots which remind one of a nucleus, but of which the nature has not yet been ascertained. The cells of which the lower part of the frond is composed have already been noticed; it is only necessary to add that the cells here are never so close together as in the upper part of the frond, and that the interstices are filled with small portions of the intercellular substance.

The chlorophyll-bodies in the club-shaped cells never fill the entire space, but keep strictly to the form of the cells, and long streaks of this substance pass through their shafts quite to the point. Starch grains, or at least starch in an amorphous state, is here always found, and even when it could not be observed the chlorophyll bodies always assumed a dark-blue colour when iodine was applied.

The intercellular substance plays a considerable part in the structure of the frond. In some species it forms as much as half of the whole mass. In others, and these are the most numerous, it is less in quantity but of equal importance. It lies, in all the species, with one exception, not only between the cells themselves, but also in the large space between the cells and the cuticle.

The cuticle is very thin and pellucid, and covers the whole frond except the fibrous-rooting processes (*fästtågorna*) before mentioned.

In the young state the frond is attached to some object by a hold-fast ((*fästnöl*), which is formed partly of the intercellular substance, and partly of the lower parts of the club-shaped cells at the base of the plant. The ends of these cells and the intercellular tubstance are both inclosed by the cuticle. The hold-fast is irregular in form, rather flat, and always very small. Instead of this hold-fast, two of the species are provided with rooting processes (*fästtågorna, fibrillæ alligantes*), which consist of a few simple fibres, and which are found on older plants after they have become detached. These fibres are nothing but the ends of the shafts of the club-shaped cells, which, instead of remaining within the cuticle, push through it, and take the place of the hold-fast.

By these root organs is Monostroma, well separated from Prasiola, to which it is otherwise near. The root-organs in Prasiola are, as Jessen has shown in his meritorious monograph on the genus Prasiola, very different. Whereas in Monostroma the cells partake in forming the hold-fast, in Prasiola the fibres proceed from the intercellular substance, and are inclosed in the cuticle. In Monostroma the fibres are simple, but in Prasiola they are branched, sometimes even anostomosing, and, in parts, almost reticulated.

Monostroma is entirely without special reproductive organs, but when the plant has reached maturity the cells become fruitful. At a certain period the contents of the cells are transformed into zoospores, which, after swimming about for a short time, fix themselves to some object and develop into young plants. As there are at least four zoospores in every cell, a middle-sized frond must produce many thousands of them; hence it will be seen what a powerful means they are of increasing and multiplying the plant.

The exact nature of these small organs has not been thoroughly studied. For what is known on the subject we are indebted to Areschoug's able essay "On the Formation of the Zoospores in *M. Grevillei*," and also to Thuret's remarkable work, "Recherches sur les Zoospores des Algues."

Nothing is known as to the way in which the zoospores are formed in the cells. All that is really known is that the parts of the cells which undergo transformation are the chlorophyll bodies, but how the green contents of the cells change into zoospores, and whether by successive or by simultaneous division, are problems still enveloped in total obscurity.

When the zoospores are formed numbers of them lie in the cells moving about their smaller ends. After a time they lie still; then, under the influence of light, they may be seen turning about in their cells as if struggling to get out of their narrow prison. A round hole then forms in the cell-membrane and in the cuticle, whence the zoospores speedily escape. After a short time the motion ceases, and they lie in the cells, where they probably soon die.

The time of the day when the zoospores issue from the cells is generally between four and six in the morning. Sometimes, especially in autumn, the swarming takes place later in the day, even in the afternoon. In some of the Ulvæ, according to Thuret, the swarming does not occur at any special time of the day.

The zoospores, in the species which are best known, are of an oval form, the lower end being drawn out into a rostrum, to which are attached two cilia, of about the same length as the zoospores. Sometimes there are found in all the species two kinds of zoospores, the one with four, the other with two cilia. The former are nearer to germinating spores, the latter to resting spores. In many other Ulvaceæ two kinds of zoospores have also been observed.

The colour of the zoospores is green, but the smaller end is lighter in colour or almost hyaline. The cilia are always colourless.

The free zoospores have a voluntary motion, and two distinct movements. First, they turn quickly each on its own axis, and secondly, they move now forwards, now in circles, then in straight lines, now one way, then another.

As to how this motion is produced, and which part of the zoospores is most efficacious in causing it, various opinions prevail. Up to the present time the most general belief is that the cilia are the locomotive organs. Another opinion was, however, expressed by Prof. Areschoug in the *Transactions* of the Academy of Upsala for the year 1866, namely, that the zoospores in motion have a power of contracting and expanding very quickly, and of very considerably changing their form; this changing of form, he considers, constitutes in itself the mechanism of motion. In this essay he has clearly proved that in the algæ then under examination, the cilia cannot be the true organs of motion.

The zoospores originate always in the cells that lie on or near the margin of the frond; they afterwards appear in abundance in the upper parts of the frond, whence they spread gradually downwards, till they fill up all the cells of the monostromatic part.

When the motion finally ceases, the zoospores fasten themselves to some object near at hand, and then begin to develop into young plants. The zoospores which, till this time, were formed of the bare protoplasm only, are now covered with a cellular membrane. The cilia disappear, and a process of division commences, which, however, in the species of this genus, has not been studied. In several other well-known Ulvæ, this division takes place first in one dimension, but afterwards in two; thus an expanded membrane is formed. This increase in size takes place, according to the observations of authors, principally, but not exclusively, in the periphery of the frond, or on the apex, if there be one. The youngest parts of the plants are thus always at the top, and the oldest at the base. In this way the frond acquires a tolerable leaf-like aspect.

As before-mentioned, the frond does not in all the species remain attached during its whole life to some object. It is often found, fresh and in full vigour, lying loosely at the bottom of the water in which it grew. Thus, according to the experience of authors, these free examples are entirely monostromatic. Hence there is reason for the opinion that, in this case, the frond divides itself into two parts, and that the division-line between them falls just on the border between the upper monostromatic part of the frond and the lower, and not monostromatic. The upper part of the frond survives for a considerable time, and generally increases in size, until the formation of zoospores begins, when it gradually decays. The fate of the other part of the frond is involved in obscurity. Dr Wittrock thinks it not improbable that the cells may detach themselves from each other, and become a kind of fixed gonidia, which finally develop into young plants. Such a mode of increasing would agree with that which, according to Kützing, occurs in several species of the genus Ulva of authors (*Phycoseris*, Ktz.), where the cells in the stipes of the plants, after the frond becomes free, put forth budding-cells. It also occurs in Prasiola.

Kützing, in his works, speaks of another kind of reproductive bodies, the so-called *Spermatia*, which he says occur in the Ulvaceæ. He describes them as brown, and as detached from the surface of the frond, also as round bodies with a thick hyaline membrane, the contents of which are brown and granular. In *Ulva latissima*, Ktz., to judge from the figure, they appear to be about three times as long as the outer cells. Dr. Wittrock had been unable, after diligent search, to find them. To Thuret their use was unknown, and Jessen supposed that they proceeded from some accidental deformity of the common cellular tissue.

No genus in the whole vegetable kingdom has so wide a range as Monostroma. It has representatives in all parts of the world, but the greater part of the species prevail in the colder parts of the European temperate zone. Of the eighteen species which are known with tolerable certainty to belong to the genus twelve are found in this zone. In the southern part of the Polar regions the genus has not less than seven representatives; in the equatorial zone one species is found; south of the range of the "wild goat," only two. In Europe there are fifteen species; in Asia, two (or, including *M. fuscum*, three); in Africa, one; in North America, one; in South America, one; and in Australia, three species.[1]

Many of the species grow in salt water, some prefer brackish, others inhabit fresh water. They grow generally in shallow water, most frequently only one or two feet below the surface; but two species often grow many fathoms under water. Some species are found at nearly all times of the year, others in the spring and summer only. All are annuals.

To facilitate examination and to preserve as much as possible the natural order, Dr. Wittrock has subjoined a tabular view of the species which he has examined. The characters are here adduced partly from the form and position of the cells as shown in a transverse section of the frond, partly from the development of the chlorophyll bodies and the thickness of the frond. The arrangement of the species in this scheme is not altogether the same as that afterwards observed in the treatise.

The species are fully, even minutely described, and the monograph is illustrated by four plates, in which magnified figures are given of the surface and transverse sections of the fronds. These are extremely useful, since the species can be determined by microscopic observation only.

MARY P. MERRIFIELD

---

[1] At present three species only of Monostroma are known to grow on the British shores, namely, *M. bullosum*, *M. Grevillei*, and *M. latissimum*. The first inhabits fresh water, the others salt water. On the north coast of France five species are found.—M. P. M.

SCIENTIFIC SERIALS

IN the most recent numbers of the *Journal of Botany* (May–July), the most interesting article is perhaps the description of a new British Umbellifer, *Selinum Carvifolia*, by Mr. F. A. Lees, illustrated by a plate. The plant is widely distributed on the Continent, and has been now discovered in Lincolnshire by the Rev. William Fowler. It has apparently been confounded with *Peucedanum palustre*, to which however it is not very nearly allied, and should be looked for elsewhere.

THE recent numbers of the *Scottish Naturalist* (October 1881–July 1882) contain the usual supply of articles on various branches of natural history, especially interesting to dwellers in or visitors to the northern parts of our island.

The American Journal of Science, June.—Respiration of plants, by W. P. Wilson.—On the question of electrification by evaporation, by S. H. Freeman.—Observations on snow and ice under pressure at temperatures below 32° F., by E. Hungerford.—On the minerals, mainly zeolites, occurring in the basalt of Table Mountain, near Golden, Colorado, by W. Cross and W. F. Hillebrand.—On a new locality for Hayesine, by N. H. Darton.—Notes on the electromagnetic theory of light, II., by J. W. Gibbs.—New phyllopod crustaceans from the Devonian of New York, by J. M. Clarke.—An organ-pipe sonometer, by W. Le Conte Stevens.

THE *Journal of the Franklin Institute*, July.—Description of the Edison steam dynamo, by T. A. Edison and C. T. Porter.—On the efficiency of the steam boiler, and on the conditions of maximum economy, by R. H. Thurston.—Note on the economy of the windmill as a prime mover, by A. R. Wolff.—Harmonic intonation of Chime bells (continued), by J. W. Nystrom.—An organ-pipe sonometer, by W. Le Conte Stevens.—Analysis of Helvite from Virginia, by R. Haines.—The absorption of metallic oxides by plants, by F. C. Phillips.—Applications of the principle of the phonodynamograph, by W. P. Cooper.—Remarks made at the closing exercises of the drawing school, May 18, 1882, by C. Sellers, jun.—Conservation of solar energy, by P. E. Chase.

THE *Bulletin of the Torrey Botanical Club* for April contains an interesting article by Mr. T. F. Allen on the "Development of the Cortex in *Chara*," illustrated by 8 plates. The author divides the species belonging to the genus into eight groups, characterised by the mode of development of the cortical cells and cortical tubes. Three new species are described.

Annalen der Physik und Chemie, No. 6.—On the electricity of flame, by J. Elster and H. Geitel.—On double refraction in glass and sulphide of carbon produced by electric induction, by H. Brongersma.—On measurement of small electric resistances, by C. Dieterici.—Note on weakly magnetic and dia-magnetic substances, by P. Silow.—Some experiments on diffusion of gases through hydrophane of Czernowitza, by G. Hüfner.—General formulæ for determination of the constants of elasticity of crystals by observation of the flexure and drilling of prisms, by W. Voigt.—On the molecular attraction of liquids for each other, by P. Volkmann.—Reply to the memoir of Herr V. v. Lang: "Determination of the quotients of refraction of a concentrated solution of cyanin," by C. Pulfrich.—Experiments on colour-mixtures, by R. Schelske.—A proof of Talbot's proposition, and remarks on some of its consequences, by F. Boas.—On the replacement of a centred system of refracting spherical surfaces by a single one of this kind, by F. Kessler.—On singing condensers, by W. Holtz.—On coloured sparks and their production by internal and external resistances, by the same.—Remarks on the production of Lichtenburg figures, by K. L. Bauer.

No. 7.—On transpiration of vapours (III. Memoir), by V. Steudel.—On the same, (IV. Memoir), by L. Meyer.—General formulæ, &c. (continued), by W. Voigt.—Volume and angular changes of crystalline bodies with omni- or uni-lateral pressure, by the same.—On the absorption of heat by gases and a method based thereupon for determination of the amount of carbonic acid of atmospheric air, by H. Heine.—On the absolute system of measurement, by P. Volkmann.—Deduction of the fundamental law of crystallography from the theory of crystalline structure, by L. Sohncke.—On the molecular-kinetic laws of heat of vaporisation and the specific heat of bodies in various forms of aggregation, by A. Walter.—On the different systems of measures for measurement of electric and magnetic quantities, by R. Clausius.—On the metallic galvanic battery of Perry and Ayrton, by B. J. Goosens.—The Waltenhofen phenomenon and the demagnetisation of iron bodies, by F. Auerbach.—On the behaviour of electricity in gases, by F. Narr.

Reale Istituto Lombardo di Scienze e Lettere, Rendiconti, vol. xv. fasc. xi.—On some formulæ relative to calculation of errors of observation, by S. A. Maggi.—On two fossiliferous planes of the Lias in Umbria, by C. F. Parona.—On the variability of *Cobitis tænia*, by E. Cantoni.—On caffeic acid obtained from *Cinchona cuprea*, by G. B. Körner.—On an herbarium about 3000 years old, by G. Cornalia.

SOCIETIES AND ACADEMIES

LONDON

Anthropological Institute, June 27.—General Pitt-Rivers, F.R.S., president, in the chair.—Mr. Villiers Stuart, M.P., exhibited and described a drawing of the funeral canopy or tent of an Egyptian queen, and some casts of bas-reliefs discovered by him within a short distance of the tent.—Mr. E. H. Man read a further account of the natives of the Andaman Islands, in which he treated more particularly of their home life; the food and methods of cooking were fully described; also the games, amusements, and dances.—A communication was received from Mr. H. C. R. Becher on some Mexican terra-cotta figures found near the ancient pyramids of San Juan Teotihuacan; from a comparison of these figures with those in the museum at Palermo the author argued that they were produced by people of the same race, and that the builders of these ancient monuments were Phœnicians.

Royal Horticultural Society, June 27.—Sir J. D. Hooker in the chair.—*Hollyhock attacked by Fungi*: Mr. W. G. Smith exhibited fruits, and an enlarged drawing, showing them to be often badly attacked by *Puccinia malvacearum*, and a *Cladosporium*, which would probably account for the presence of the Uredo noticed by Mr. Berkeley in the germinating plants.—*Hybrid Lily*: Mr. G. F. Wilson exhibited a very remarkable hybrid between *L. Washingtonianum* and *L. superbum*, which had the foliage of the former, but flowers more like those of the latter.—*Synanthic campanulas*: Mr. G. S. Boulger mentioned that Mr. Gibbs, of Chelmsford, had fertilised a common form of Campanula (with catacorolla), with the pollen of a synanthic blossom. He had raised 200 plants, and many had synanthic flowers.—*Retinospora sport*: Dr. M. T. Masters exhibited a specimen of *R. squarrosa*, which had borne a branch with the characters of *R. pisifera*, proving these supposed species to be one.—*Monstrous Flowers*: Dr. Masters exhibited virescent flowers of Auricula; Mr. Laing, a rose-pink double Begonia, with axillary prolifications of double flowers besides a terminal one, all proceeding from the centre of a male flower; the female flowers being compact and double, but not proliferous to the same extent.—The Rev. G. Henslow exhibited a branch of wallflower covered with minute and almost capillary leaves.

July 11.—Dr. M. T. Masters in the chair.—*Hollyhock disease*: Mr. W. G. Smith exhibited fruits of *Malva sylvestris* with *Puccinia malvacearum*. They confirmed the correctness of his view that the fruits infected by this fungus fall to the ground, and are then capable of producing seedlings diseased with *Uredo* without the intervening *æcidium* stage, as in the case of the hollyhock mentioned above.—*Scolopendrium, diseased*: he also showed the harts-tongue fern attacked by *Didymium effusum*, Lk., a myxomycetous fungus, new to Great Britain. It occurs on both sides of the frond, and grows over the ruptured masses of spore-cases, and even amongst the free spores (for description and figures see *Gardeners' Chronicle*, July 15, 1882).—*Clematis and oat* roots attacked by vibrio (*Tylenchus*, sp. ?): Dr. Masters showed specimens and observed that it was only one variety of black oat which was attacked, but that to such an extent as to destroy whole crops.—*Gardenia and Petroleum*: he brought a spray to show its healthiness after being treated by syringing with this oil and water (a wine-glass to a gallon), to destroy mealy bug.—*Water-lily with foliaceous sepal*: he also exhibited a specimen in which one sepal had developed a leaf-blade at its apex, proving that (as is usually the case) a sepal is homologous with the basal part of the petiole only.—*Coloured pea-poas*: Mr. Laxton of Bedford sent green, purple, and speckled pods, the latter a result from crossing the two former. The purple colour appears to overlie the chlorophyll, which it thereby conceals.—*Antirrhinum Hendersoni*: Mr. Cannell forwarded sprays of this race, which has white flowers with crimson border, but which will not set seed, this being apparently due to atrophy of the pollen. The anthers had dehisced even in bud, and such few pollen-grains as were present were minute and abortive. The ovules, however, appeared to be normal; yet the race does not seem capable of being crossed. Mr. Henslow remarked that when white and purple snapdragons werh crossed the result is usually a streaked corolla with no certainty in the markings as in the present case.—*Aerial petato-tubers*: the Rev. G. Henslow exhibited tubers found in the axils of leaves. He also showed plum leaves perforated with small circular holes, caused by raindrops concentrating the sun's rays, which had thus burnt them.

EDINBURGH

Royal Society, July 3.—Prof. Maclagan, in the chair.—Prof. Tait, in a note on the kinetic theory in relation to dissociation, stated that it followed from that theory as ordinarily enunciated that dissociation should take place at all temperatures, though of course very slowly at low temperatures. This, according to the chemists, was irreconcileable with the facts. It appeared, then, that a slight modification of the kinetic theory is necessary, so as to restrict the utmost ratio in which the velocity of an individual particle may exceed the velocity of mean square. This would entirely remove the difficulty, while in no way interfering with the success of the theory in other directions. A strong analogy in favour of this is afforded by the equation of diffusion and of conduction, from which an infinite velocity is assigned under certain cases to a particle of salt in water. This arises at once from the assumption that the diffusion is always directly proportional to the gradient of strength, however small that gradient may be.—Dr. Knott communicated a brief paper by Mr. Albert Campbell on experiments on the Peltier effect, in which the author had obtained by a very simple method the ratio of the Peltier effect for a given pair of metals at 20° C. to that at 100° C. The pairs he experimented on were iron-lead, iron-zinc, iron-german silver, and lead-silver; and the ratios obtained for these differed in no case more than 8 per cent. from the values indicated on Prof. Tait's thermo-electric diagram—a remarkably close agreement, considering how much metals of the same name differ in their thermo-electric properties.—Prof. Marshall read the continuation of the paper by himself, Prof. C. Michie Smith, and Mr. R. T. Omond, on the lowering of the maximum density point of water by pressure. They had repeated their former experiments with fresh water, and had investigated similarly salt water of about the same density as sea-water. Salt water apparently had no maximum density point at ordinary pressure—a fact previously known—or rather the maximum density point as calculated from a modification of Thomson's formula expressing the thermal effect due to any sudden compression in terms of that compression, is, so to speak imaginary, lying below the freezing-point. The results with salt water are important, as giving greater confidence in their method, so that the lowering of the density-point of fresh water by 5° C., by a pressure of one ton weight on the square inch may be accepted as not far from the truth.—The Rev. J. L. Blake read a paper on vocalisation and articulation, which was a continuation of his former paper on breath-pressure, and in which he considered specially the actions of the various muscles on the lungs and vocal organs in producing speech, pointing out what he considered the chief differences in the actions which accompany breathing, speaking, and singing.

BERLIN

Physiological Society, June 2.—In our account of this meeting (NATURE, vol. xxvi. p. 216), by an oversight a page of the report was omitted. At the close of the notice of Prof. Kronecker's report on Dr. Melzer's experiments on the action of the vagus, and before the words "Since Hunter's time," the following paragraph should have been inserted:—"Prof. du Bois-Reymond read a second report on the recently instituted researches of Prof. Fritsch in [illegible] and the Mediterranean, on electric fishes. After Fritsch had satisfied himself as mentioned in the former communication, that Mormyrus was an electric fish, he thoroughly examined its central nervous system. He found the spinal marrow, when in a fresh state, to be a soft mass, which could be hardened by no medium so as to be made accessible for examination. On the other hand, the brain was of so high a degree of development, that it is even beyond that of the birds, and has a resemblance to that of a rabbit. Furthermore, Prof. Fritsch has examined a great number of Torpedoes from the Mediterranean, and he had made out four distinct species with their respective varieties. Into the specific diagnoses he introduced the number of the columns or pillars in the electric organs, and this because he found—as the result of a long series of careful countings—that the proposition as to the pre-formation of the electric organs (*i.e.* the doctrine that in the electric organs, after their first formation, no new elements are added), was true. The opposite view, that during growth new pillars were continually being formed, until very lately was almost universally held, and seems to have rested on Hunter's authority, who, towards the end of the last century, had made two series of countings, one on a common Torpedo, eighteen inches long, in which were 470 pillars, and one on a giant Torpedo, caught at Torbay, four feet in length, which contained 1182 columns. Hunter seems to have taken it for granted that the larger animal was but an older specimen of the same species, and had thence concluded that the pillars had increased during growth."

June 30.—Prof. du Bois-Reymond in the chair.—Dr. G. Salomon read a paper on his attempt to investigate more exactly the xanthin bodies of urine. He especially investigated the hypo-xanthin and its reactions, and in doing so found a new substance which easily crystallised, and which for the present he called para-xanthin, from its relation to xanthin. From the small quantity it was as yet not possible to make an accurate analysis of it, even though 500 litres of urine had been used in the investigations.—Dr. A. Baginski spoke of the anatomy of the colon in children. He endeavoured to find in the minute anatomy of the colon in infants, an explanation of the well-known fact that children during the first few years of their life can either not digest food containing starch, or at least do so with greater difficulty than adults. He found on the examination of the colon of the human embryo, and of infants up to their fourth year, that in the fœtus, and even after birth, there were no drusæ as yet in the mucous membrane of the stomach and colon, while in the infant the deeper lymphatic vessels were more strongly developed than in the adult.

Paris

Academy of Sciences, July 10.—M. Blanchard in the chair.—The following papers were read:—On the differential equation which gives immediately the solution of the problem of three bodies to quantities of the second order inclusively, by M. Gyldén.—On various hydrates formed by pressure and release from pressure, by MM. Cailletet and Bordet. They compressed phosphuretted hydrogen in presence of water; on sudden release, crystals of what is doubtless a hydrate of phosphonium were formed within the tube. The critical point was + 28°. Other hydrates were had on treating similarly equal volumes of carbonic acid and phosphuretted hydrogen with water, dry phosphuretted hydrogen, and sulphide of carbon, and ammoniac gas in presence of a saturated solution of that substance (a hydrate of ammonia was formed in the latter case on the admission of some air).—Note on Brisinga, by M. Perrier. The *Travailleur* expeditions have yielded a splendid specimen, almost complete, sixteen well-preserved discs, two very young individuals, and a great many isolated arms. They are mostly *B. coronata*, the large one *B. endecacnemos*. A distinct form got in the Atlantic in 1880 is named *B. Edwardsii*. The development of *Brisinga*, bordering with that of crinoids on the one hand, is singularly like that of Ophiurides and Stellerides on the other.—Researches on the law of activity of the heart, by M. Dastre. He gives experimental proof that the law of periodic variation of the excitability (Marey) is an attribute of muscle, and that the law of uniformity of work or of rhythm (E. Cyon, Marey) is an attribute of the nervous apparatus.—Generalised and contagious *acné indurata*, having for origin varioliform or varioloid acné, by M. Brame.—On a linear equation with partial derivatives, by M. Darboux.—On the ratio of the circumference to the diameter, and on the Napierian logarithms of commensurable numbers or of algebraic irrationals, by M. Lindemann.—Rectification, by M. Tannery.—On the conditions of achromatism in phenomena of interference, by M. Hurion.—Apparatus, with which may be recorded, in the form of a continuous curve, the liberation or the absorption of gases, and specially those which result from phenomena of fermentation and of respiration, by M. Regnard. Briefly, the gas from a vessel of liquid in fermentation acts on mercury in one arm of a manometer, a float in the other arm rises and pushes up one arm of a balance, making a platinum wire on the other arm dip in mercury and close a circuit. The current passes through two electro-magnets, one of which affects a style on a rotated blackened cylinder (through a ratchet and screw arrangement); the other, by raising a small bell out of mercury, releases the gaseous tension, so that the circuit is broken, and so on. The second apparatus, for respiration, is a slightly modified form.—Reply to M. Berthelot on the subject of the note "On the electromotive force of a zinc-carbon couple," by M. Tommasi.—On basic salts of manganese, by M. Gorgeu.—Action of bromine on quinoleine and pyridine, by M. Grimaux.—Researches on the curves of solubility in water of the different varieties of tartaric acid, by M. Leidie.—Botanical, chemical, and therapeutical researches on globularia, by MM Heckel, Mourson, and Schlagdenhauffen. They differ from Walz about the chemical nature of the glycoid *globularine*, obtained (along with tannin, colouring matter, and cinnamic acid) by means of boiling water from the leaves. Instead of two products of decomposition under acids, they obtain only one, for which they keep the name *globularetine*; it is oily and resinous-looking after preparation, and becomes a transparent uncrystallisable mass. In hot caustic alkalis it dissolves, fixes the elements of water, and is transformed into cinnamic acid. Globularine contains also a little of a very volatile aromatic substance, which seems to be partly formed of cinnamate of benzyl.—On the presence of glycol in wine, by M. Henninger.—On the duration of the luminous perception in direct and indirect vision, by M. Charpentier. The person gave an electric signal on perceiving light through a hole in the bottom of a dark lined box, when a shutter fell from it. The interval studied (duration of luminous perception) varies in the same individual under like conditions, from simple to double, but a constant mean may be reached (*e.g.*, 13 hundredths of a sec., with daylight). It varies with different persons; is about the same with both eyes; is notably increased by other brain occupation; is greater in indirect than in direct vision; exercise attenuating but not suppressing the difference. Exercise for many days lessens the duration, but in certain curious ways for different parts of the retina.—Regeneration of peripheric nerves by the process of tubular suture, by M. Vanlair.—Experimental researches on the contractility of the uterus under the influence of direct excitations, by M. Dembo. The remarkable uterine excitability of the rabbit, may be connected with the fecundity of that animal. Dogs and cats gave slight contractions.—Analysis of the waters of the isthmus of Panama, by M. Aillaud. The waters of the Rio Grande, at a certain height, and before entrance into the marshy region, are potable.—On the coal basins of Tong-King, by M. Fuchs. The workable coal, to only 100 m. below the sea level, is estimated to be over five million tons. There are four different species in distinct groups of beds.

CONTENTS

THURSDAY, JULY 27, 1882

THE MODERN APPLICATIONS OF ELECTRICITY

The Modern Applications of Electricity. By E. Hospitalier. Translated and Enlarged by Julius Maier, Ph.D. (London: Kegan Paul, Trench, and Co., 1882.)

THIS book professes to be a popular account of all the more important practical applications of electricity that have during the last five years drawn so much public attention to that science. No better popular book than that of M. Hospitalier has appeared, and were it not for certain defects, chiefly of style, the present translation by Dr. Julius Maier would have been admirable. It deals in a fairly easy and at the same time fairly accurate manner with many technical matters, and will no doubt prove a very popular work. Part I. treats of the sources of electricity—batteries and dynamo-electric machines. Part II., which is naturally the largest section of the work, is devoted to Electric Lighting. Part III., the least satisfactory perhaps of the whole, and the one that has suffered most by the fact of being a translation of a foreign work, comprises Telephones and Microphones. In the fourth and last section a number of miscellaneous applications are described, including Electric Motors.

We have referred above to certain defects of style apparent in the work before us. It is unusual, to say the least, to speak of the "blades" of a battery in referring to the plates of metal or electrodes. Still less usual is it to call the electrode-poles "rheophores"; a term which probably a great many electricians in this country have never used and do not know of. Neither is it usual to speak of a steam-engine as a "vapor-motor." There are objections against the novel use made by the author or his translator of the term "electrodynamic" as a general adjective to comprise both "magneto-electric" and "dynamo-electric" machines. The word "electrodynamic" has already its own accepted use in the science; and if any extension of that use is necessary, all analogy requires that that extension should be in a direction different from that attempted. It is a dangerous experiment in a "popular" book to meddle with accepted technical terms; for besides being misleading to the public when they subsequently attempt to read other and more strictly scientific books, it makes the author of the popular work look as if he did not understand what he was writing about, when he uses accepted terms in a meaning other than their accepted one. There are other points that strike one as defects. What will the ordinary reader make out of such a sentence as that with which Chapter I. opens? "We can form a fairly exact idea of a battery by comparing it to a focus (*sic*) of heat; *for instance, the furnace of a boiler*." Or this (p. 14): "To continue our comparison between a battery, the focus of electricity and a focus of heat, we say that *polarisation in a battery is analogous to the want of draught in a chimney*." This precious piece of nonsense is nearly equalled by the following: "The battery is only used now *in law courts, in national assemblies*, and by some experimenters who for some reason or other cannot set up a steam or gas motor." (These italics are ours.)

But worse than these mild absurdities there are a few positive errors which no reviewer can conscientiously pass over. There is so much that is excellent in M. Hospitalier's work, that it might seem ungracious to point them out. But the only way to keep up the standard of popular scientific works is to point out where their scientific sins lie. In a section devoted to electrical units, we are first told that the "unit of intensity" is the *ampère*. As the author habitually uses "intensity" for electromotive force ("it corresponds to what the French call 'tension,'" he says), we must beg to remark that the definition is wrong. But the book goes on to say (p. 8):—"The ampère is really a perfectly distinct *quantity* of electricity, as a litre is a definite volume, and a kilogramme is definite weight." Wrong again; for the ampère is the standard unit of *strength of current*, and not of either "intensity" or "quantity." To make matters worse, the author adds the following explanation:—"If we say that the intensity of the current traversing a wire is one ampère, we mean by that that the quantity of the current traversing this wire *during one second*, if the current preserves the same intensity, is one ampère." This statement is happily contradicted by one standing on the opposite page of the book, namely, that "a current with an intensity of one ampère yields per second a quantity of electricity equal to one coulomb." But how is the unfortunate reader to know which of these to believe?

The author and translator are more at home in the applications of electricity. Here, however, we must protest against several misstatements and errors. On page 81 comes the preposterous dictum that "*Edison's coil is exactly like Gramme's*," a statement so absurd that we have only to remind the reader that the Edison armature, so far from being like that of Gramme, coiled on an iron *ring*, is so precisely like that of Siemens, wound shuttlewise along a *cylinder*, that, as everybody knows, Edison pays Siemens a royalty for the use of this principle. At another part of the book the armature of the Brush machine is said to be "in principle a Pacinotti's ring," but of that famous machine which anticipated that of Gramme, not only in the employment of a ring-armature but in the application of the segmental collector or commutator, and which differs from Brush far more than it differs from Gramme, the authors maintain a complete silence. They speak of the Gramme "collector" as though Pacinotti had never existed.

Turning to incandescent lamps, we find those of Swan, Lane-Fox, and Maxim, fairly described; and due credit is given to these pioneers of the principle of the incandescent lamp. But of Edison's lamp a very poor account indeed is vouchsafed; the filament-lamp of charred bamboo being just casually mentioned, whilst his older lamp, with its horse-shoe of stamped paper, is figured and dedescribed in detail.

In describing Faure's accumulator, a modification (due, we believe, to Dr. Fleming) consisting of a number of lead trays, coated with red lead and piled up vertically, is mentioned as if this were the original form. Moreover, we doubt whether "the happy idea of *filling up* the space between the lead plates used by Planté with red lead," would by any means produce the result of "vastly increasing the usefulness" of that excellent apparatus: it would rather destroy it by short-circuiting it.

Lastly, we must protest against the treatment given to Reis's Telephone, of which the book declares that it "has always remained a purely musical apparatus." It is perfectly clear that neither M. Hospitalier nor Dr. Maier can have read Reis's own papers when they make this assertion, which those papers amply refute, and which a careful trial of Reis's own instruments will also amply contradict. Reis invented his instrument, taking the human ear as pattern, *because* the human ear can vibrate to all kind of sounds. He invented it, meaning it to transmit speech, and though it transmitted music better than speech—and both imperfectly—it did, to a certain degree, fulfil its inventor's aim. The author seems in fact to have viewed Reis's invention through the hazy medium of the writings of Count du Moncel, or some less reliable authority; for he mentions Yeates's experiments of 1865 (in which articulate speech was transmitted by a modified Reis instrument with such accuracy that the voices of individual speakers were recognised), and then adds: "The musical telephone might have become an articulating telephone under these conditions, *but this result was not obtained*, partly on account of the imperfection of the instrument, and *partly because Yeates had no such result in view!*" How this extraordinary distortion of well-known facts has crept into the book before us we are at a loss to conjecture. Doubtless the numerous excellent illustrations with which the book is adorned will procure for it a ready sale.

HANDBOOK FOR NORTHERN AND CENTRAL JAPAN

A Handbook for Travellers in Central and Northern Japan, &c., with Maps and Plans. By Ernest Mason Satow, Second Secretary and Japanese Secretary to H.B.M. Legation, and Lieut. A. G. S. Hawes, Royal Marines (Retired). (Yokohama: Kelly and Co.; Shanghai: Kelly and Walsh, 1881.)

AS a mere handbook this work is indispensable to the European traveller in Japan. But it is much more than a handbook, it not only indicates what is sightworthy, but explains by illustrative myth or legend, drawn from local tradition or from the little explored treasures of Japanese literature, the special interest with which mountains, temples, mounds, groves, and places are invested in the eyes of such Japanese as have not yet abandoned their nationality. To readers of this journal the most valuable portion of the book will be the description as accurate as minute of the Alpine region formed by the provinces of Etchiu and Hida (now the prefectures of Ishikawa and Gifu)—a region difficult of access even to natives, and almost untrodden by Europeans. The mountain range bounding this wild and remote tract on the East is the most considerable in Japan, extending nearly due north and south for some sixty or seventy miles, and rugged with innumerable peaks, the most conspicuous of which, beginning from the north, are Tatéyama, 9500 feet, Goroku-daké, 9100 feet, Yari-ga-také, 10,000 feet, and Norikura, 9800 feet. The chain is not of homogeneous structure, nor are the peaks of contemporaneous origin. The basis is a closegrained granite, not unfrequently rich in garnets. Through this backbone or axis vast masses of igneous and volcanic rock have been extruded, the volcanic rock principally trachytic, often coarse-grained, and occasionally (Tate-yama) columnar. Of the peaks, Yari-ga-také (spear-peak) seems the most ancient, and consists of an intensely hard, foliated rock with curiously contorted siliceous bands and of an almost equally hard porphyry breccia. Nori-kura (ride-saddle) and Tatéyama (steep-hill) are both volcanic. Goroku-daké or Renge (Lotus flower Peak) consists of a mass of trachytic porphyry piled upon and against a close-grained granitic rock. The lower slopes of the range are overlaid, say our authors, by sedimentary rocks, but I am inclined to doubt the accuracy of this statement. Under the fierce sun and incessant rain of summer aërial denudation proceeds at a great rate, especially in the granitic districts of Japan, as may be well seen in the neighbourhood of Kobé, and the existence of a quasi-sedimentary rock may thus be easily accounted for. But true sedimentary rocks, excluding lacustrine deposits or fluvial alluvia, require the agency of the sea, and the greater part of the covering strata of the Japanese islands, is of very recent origin, and has never been under the sea. Only for a few days in early autumn does snow disappear from these peaks, the curiously abrupt and jagged outlines of which recall and even justify the mountain-forms common in Chinese pictures. The fauna of the district is little known. Ptarmigans are common, so also are flying squirrels, as well as bears, two species, of wild boar, and the curious goat-faced antelope. The flora has been more studied. Dense forests clothe the slopes, principally of beech and of several species of oak, mostly evergreen. Conifers are less abundant than is common in Japan. But the pretty 5-leaved *Pinus parviflora*, S. and Z., as well as, though to a less extent, *Cryptomeria japonica*, *Chamæcyparis obtusa*, S. and Z., and *C. pisifera*, S. and Z., are not infrequent. I am not sure, for reasons too long to state here, that the Cryptomeria, despite its frequency, is indigenous to Japan. Two or three kinds of Betula show themselves at elevations of 4000-5000 feet. Below this level many examples of the genera Epilobium, Scabiosa, Hypericum, Parnassia, Euphrasia, Lilium (*L. auratum* and *L. tigrinum*), Hydrangea, Smilax, Akebia, Tylophora, &c., constitute a vegetation by no means without a western European aspect. Above 5000 feet Vaccinium, Diphylleia, Trollius, Paris, *Fragaria vesca*, and Anemone make their appearance. The common Pinguicula is also found, and probably *Loiseleuria procumbens*, which I have gathered on the slopes of Asama-yama, finds a home on those of the Hida mountains. Above 8000 feet a small Dicentra (*D. pusilla*, S. and Z.?), a yellow violet, *Shortia uniflora*, and *Schizocodon soldanelloides* are to be seen interspersed among bushes of a dwarf azalea. But it is doubtful whether any true Alpine flora exists in Japan.

On Taté-yama the climber passes by some hexagonally columnar examples of andesite, said to have been originally prostrate trunks of trees over which a woman incautiously stepped, which so offended the deities that they were changed into useless blocks of stone. The spot is called Zai-moku-zaka or timber-steep to this day, in commemoration of the fact. Solfataras, it should be mentioned, are as common in this district as in other parts of Japan. A curious means of crossing deep ravines and precipitously walled valleys, known as Kagono-watashi—basket-crossing—is much used in these provinces. A sort of wicker cradle is suspended on hempen ropes slung across the valley, and is drawn by lines to one side or the other, or, as is more usually the case, the peasant crosses without assistance. Entering the cradle, he seizes the ropes above with his hands, and by a series of dexterous jerks, needing considerable practice for their due accomplishment, takes himself and the cage across. The great danger seems to be that of getting the cradle from under him, and thus leaving his body suspended in mid-air. His struggles are represented no less quaintly than vigorously in a drawing by Hokusai, to be found in the 13th volume of his Manguwa, or Rough Sketches.

A distinguishing feature of the book is the elaborate account given of the principal mountains, most of which have been ascended by the authors. Fuji, of course, is the highest, Dr. Rein making it 12,280 feet, Mr. Stewart 12,365 feet. The curiously jagged outline of the comparatively narrow rim of the crater shows doubtless that the broad deep cavity, of which the diameter is about 1500 feet, and the depth about 550 feet, was usually full of boiling lava, spurted up from time to time in the manner described by Miss Bird in her graphic description of the great volcanic districts of Kilauea and Mauna Loa. It is not mentioned that the two wells on the summit, on the edge almost of the crater itself, the Famous Golden Water and the Famous Silver Water, derive their supply from hoards of snow preserved by overlying masses of wind-heaped scoriæ, and volcanic dust from perishing under the fiery rays of the summer sun. One of the most interesting of the many peaks which Messrs. Satow and Hawes are the only Europeans who have ascended, is Mount Ganjiu, of which the shapely outlines rise in beautiful logarithmic curves high over the plains of Nambu. The mountain consists of three volcanic cone-frusta "telescoped" into each other. The lower cone is of course the oldest, the rim of its crater being still distinct at a height of about 5000 feet. A smaller cone about 600 feet high, rises within this, the rim of the crater of which is nearly equally distinct, and a third and smallest cone tops all, having a height of not more than 100 feet, and showing a crater at its summit, from which jets of steam still issue.

It is noteworthy that in Japan the names of rivers, capes, plains, and villages are usually pure Japanese, those of mountains more commonly Chinese. Some of the place names in the northern part of the main island have a distinctly Aino character, for instance, such a name as Namakunai, and many of the names ending in "bé," a corruption of "betsu," the Aino word for river.

Two capital maps accompany the book, which the stay-at-home reader will find as full of curious lore as the traveller of valuable information.

FREDK. V. DICKINS

OUR BOOK SHELF

Studies in Nidderdale. By Joseph Lucas, F.G.S., F.M.S., Telford Medallist of the Institution of Civil Engineers, Associate of the Institute of Surveyors. (London: Elliot Stock. Pateley Bridge: Thomas Thorpe.)

THIS book is the result of notes and observations other than geological, made in Nidderdale during the progress of the Government Geological Survey of that district, between the years 1867 and 1872.

Nidderdale is a remote pastoral valley, formed by the River Nidd, which takes its rise near the mountains of Great and Little Whernside, and which, after a course of about thirty-five miles, joins the Ouse near York.

The basin of the Nidd, above Hampsthwaite, includes an area of eighty square miles, and for sixteen miles from Great Whernside, the valley proper is nowhere more than one mile wide from ridge to ridge, and is from 500 to 800 feet deep, forming as it were a deep groove in the vast easterly sloping heather-covered moorland.

After a few introductory remarks upon the geology and geography of Nidderdale, Mr. Lucas deals with the cattle, sheep, and other matters connected with the farm, including instructive and exhaustive discussions upon the various names. In the dairy department we have the *kern* (old Norse, kirna—a churn), now a revolving barrel or tub, on a horizontal axis, the *sile* (old Norse, sahl—a sieve), and *sine*, Saxon *sihan*—to strain; and the "lile roond thithel" for stirring cream. The old cheese press is described in detail, and there is an excellent drawing of a very old form of that dairy implement, very like such as we remember to have seen long ago in remote rural districts in the north. Then there is a very interesting chapter upon the farm itself, in which Mr. Lucas introduces a farmer speaking in the dialect, and describing by their appropriate names and uses, the various buildings, fields, and animals to be found upon his farm; interspersed with these the author has put the various Norse, Anglo-Saxon, or Celtic words, from which many words in the folk speech have been derived, so that we have a means of tracing the sources of the dialect while we are becoming acquainted with its local use.

Mr. Lucas must have had opportunities such as very few others could have had, to trace out the natural science of the district, and as the passage will give a good idea of concise and clear style in which the book is written, we give an extract from the chapter on "Vestiges of the Ancient Forest."

"Nidderdale and its moors have formerly been covered by an extensive forest. Many trees lie buried in the peat upon the moors. In the thousands of sections made by little water-courses, the birch appears almost everywhere predominant. Hazel 'sealh' (willows), thorn, oaks, &c., also occur, but the birch must have formed a thick and almost universal forest by itself, such as may be seen on the west coast of Norway at the present day. The upper parts of the moorland gills, and much of what is now the moors, must formerly have made a beautiful appearance with its light gauze-like forest of birch and mountain-ash. The last surviving example on any considerable scale is present in Birk Gill, a tributary of the River Burn. The run of the Gill is north-west to south-east. The Gill is about 400 feet deep at its mouth, and half a mile wide from ridge to ridge. Like all other valleys of the same elevation in these hills, it is boat-shaped in section, the beck running in a deep ravine at the bottom. The sides of the hills are wild heathery moorland, crowned with fine lines of crags down to the edge of this ravine in which the native forest is preserved. There is no cultivation in the Gill, the bottom of which is about 600 feet above the sea at its mouth. The belt of wood clothes the sides for 200 feet, or up to 800 feet near its mouth, and ends where the stream reaches 900 feet in a distance of rather more than a mile. Above this the stream is called Barnley Beck. The wood consists of mountain ash, alder, oak, ash, birch, holly, and thorn, running above the edge of the cleft with a delightfully irregular and feathery margin on the ling covered moor." Subjoined to this is an elaborate table giving the aspect, height, and soil of the various trees found in this valley. A chapter is devoted to the modern botany of the valley, upon which there are also valuable notes in the introduction by Mr. J. G.

Baker, F.R.S., of Kew Gardens. Mr. Lucas is by no means backward in acknowledging by whom he has been aided in the completion of the work, and amongst others there are numerous and valuable contributions by Mr. J. R. Dakyns, M.A., Cantab. (of H. M. Geological Survey), both in the foot-notes and in the text.

Notwithstanding this, however, the book is an original work, everywhere bearing abundant evidence that the materials have not been compiled, but in great part collected upon the spot, and carefully worked out by the author himself. And as there are many secluded valleys in Cumberland, Westmoreland, and Yorkshire, in which the customs, manners, and folk-speech differ very little from that of Nidderdale, we think the volume deserves a much wider circulation than in the district of that valley from which it takes its name. Six of the concluding chapters are devoted to the birds of Nidderdale. These chapters on natural history are the most pleasing in the book, and contain information respecting the distribution of many birds which is altogether new. After these there is a well-told story in the dialect ("Dicky and Micky Date") by Thomas Thorpe.

Probably the most valuable, and certainly the most laborious portion of the work, is the glossary of the dialects of Nidderdale, with which it concludes.

Local glossaries no doubt there are without number, of the northern dialects, but we have never before seen one which has traced with such clearness, both from its use and derivation, each word to its source. A residence of over forty years in some of those remote regions in which a corresponding dialect is spoken, enables us to testify that Mr. Lucas has been wonderfully accurate and exhaustive in laying hold of the vocables of the district; and the pains and skill with which he has traced them through the Norse and other cognate languages, must be seen before they can be properly understood. T. E.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Sun-spot Period

THE sight of my *bête noire*, that part of Wolf's sun-spot curve lying between the years 1706 and 1799, so clearly plotted in the communication by Prof. Stanley Jevons, on "The Solar-Commercial Cycle" (NATURE, vol. xxvi. pp. 226–28), impels me to offer some remarks having special reference to solar periodicity at that time.

In a paper read at the meeting of the British Association in York last year, I ascribed the sun-spots to planetary tides in the solar atmosphere. It is not pretended that what was advanced amounted to demonstration, but the assumption had this practical result—it led me to the conclusion that the sun-spot maxima and minima, recognised in what is known as the sun-spot period, are, on the whole, determined by the relative positions of the planets Venus, Earth, and Jupiter. The maxima are nearly always associated with configurations in which Venus and Earth in conjunction or opposition, have Jupiter in or near syzygy or quadrature; while the minima are even more certainly associated with configurations in which Venus and Earth in conjunction or opposition, have Jupiter in or near the octant.

There are, however, significant deviations from this general law, and the maximum to which Wolf assigns the date 1788·1 occurs at a time when the law would give a minimum. Now it may be admitted, that at times special conditions prevail, arising from changes within the sun itself, or from the advent of material agglomerations foreign to our system. I prefer, nevertheless, to assume for the present, that the explanation of such periodicity as has been established is within the resources of a planetary hypothesis. Accepting the sun-spot record as read for us by Prof. Wolf, because we have nothing better, it is inferred that the apparent anomalies of the period in question are due to exceptional planetary configurations.

The following statement shows how lamentably observation and theory are at variance, in regard to the sun-spot numbers, near the dates 1778 and 1789:—

Years of Maximum Annual Sun-Spot Numbers

Observation

1761	1769	1778	1789	1804

Hypothesis

1761	1771	1783	1794	1804

The remarkable series of corn-prices, as given by Prof. Jevons, however shows maxima so fairly in accord with the hypothetical maxima that I am tempted to quote them:—

Years of Maximum Corn-price at Delhi

1763	1773	1783	1792	1803

If this relation is anything more than a coincidence, an important question arises. Are we to consider the sun-spot record defective, and reject the maxima of 1778 and 1789, because they cannot be traced in the corn-prices? Not necessarily, it seems to me. The sun-spot record may not be reliable, and with its revision difficulties may vanish, but there is something very substantial about the maximum of 1789, and it must be remembered that it is one thing to measure a sun-spot, and quite another thing to use a sun-spot as a measure. The sun-spot tells of solar disturbance, but the attendant changes in solar radiant forces will be changes in quality as well as in quantity, and it may be taken for granted that there are solar periods that are not to be found in the sun-spot numbers directly. One outcome of the researches of Dr. Köppen has been the recognition of what is called the period of the "Umkehrung," or inversion, so named because the more usual relations of sun-spots and air temperatures are supposed to be reversed during this particular period, which lies between the years 1770 and 1816, or thereabouts. Double-edged weapons are, however, dangerous, and must be used with caution.

Sun-spot measurement itself is a somewhat arbitrary process. The "relative number" for a given day is ten times the number of groups, plus the number of individual spots; while the method initiated by the Kew observers, and now adopted at Greenwich, gives "spotted area," that is, the proportion of the sun's surface covered by such spots as may be visible on that day. It would be interesting to compare the positions of the great spots seen in April last, as given on the annual sun-spot rolls at Zürich and Greenwich respectively. Moreover, certain well-marked distinctions in the character of the disturbance have no place, or next to none, in sun-spot measure—the faculæ are ignored, while umbra and penumbra are lumped together.

It should be remarked that observation and hypothesis agree in the total number of periods, so that, the length of the mean sun-spot period remains unaltered, unless it is decided that certain observed maxima may be taken in addition to the hypothetical maxima, and not as replacing them. The planetary hypothesis requires that the sun-spot series shall be considered as a compound series, representing a number of more or less important series of planetary periods, and it is to be expected that at times there will be a difficulty in tracing any dominant series of periods, whether primary or derivative.

It seems to me that too much importance is apt to be attached to the *mean* sun-spot period, seeing that its occurrence is exceptional, and the departure from it very considerable.

That these observations should be inconclusive is a matter of course, but my purpose will be served, if they tend to produce the impression, that there may be no real solution of continuity in the relation between the sun-spot numbers and the particular series of planetary periods that I believe to give "the sun-spot period" a rational basis. F. B. EDMONDS

72, Portsdown Road, London, W., July 14

Messrs. McAlpine's Atlases

WILL you allow me space in your columns to make a few remarks upon the "Biological Atlas" of Messrs. D. and A. McAlpine, and the "Zoological Atlases" of the first of these gentlemen?

Mr. D. McAlpine was, some three or four years ago, a student in the biological laboratory at South Kensington, and, after a diligent attendance at Prof. Huxley's eighty odd lectures, and at the five months' practical work, he succeeded in passing the examination in the second class. The two following years Mr. McAlpine, with laudable perseverance, again presented himself for examination, each time appearing a place or two lower in the second class.

While working at South Kensington Mr. McAlpine made several copies of the diagrams of type dissections in the laboratory, which diagrams are for the most part enlargements of my original drawings made by my friend and former colleague, Mr. G. B. Howes. I naturally imagined that Mr. McAlpine, like other students who had taken the same trouble, intended to use these copies either for his private work or for his classes in Edinburgh, and I was, therefore, greatly surprised at the appearance of the Biological Atlas, to find in it a number of marvellously inaccurate copies of these same diagrams, published not only without permission, but without the slightest reference to their source even in the preface.

In the Zoological Atlas (Vertebrata) the same thing occurs, and my diagrams, although strangely altered, are quite recognisable; in the figure of the skate's nervous system, for instance, I notice, copied with unusual accuracy, a mistake as to the origin of the orbito-nasal nerve, which occurred in my original drawing, but which has subsequently been corrected.

In the cases where Mr. McAlpine, having no diagrams to copy, has had to depend upon his own dissections and the statements in text-books, the results are sometimes remarkable. As an instance, I may take the ingenious diagram of the skate's vascular system, in which *paired* caudal veins are shown accompanying the caudal artery, and passing directly into the corresponding cardinal veins, the renal portal systems being completely suppressed.

According to the advertisements, the *Athenæum* recommends the "Biological Atlas" to all students of the subject; I regret that I cannot agree with your contemporary; in my opinion no books could possibly be more mischievous to a beginner than these, since they hold up for his example and imitation a work of the most inaccurate and slovenly description; as indeed, if possessed of ordinary powers of observation, he cannot fail to find out for himself before he has been a month at the subject.

T. JEFFERY PARKER

Otago University Museum, Dunedin, N.Z., March 24

Palæolithic Implements—New Localities in the Thames Valley, near London

IN NATURE, for July 15, 1880, p. 253, Mr. P. H. Pepys drew attention to a section then being made through beds of river gravel and brick earth near the West Drayton Station of the Great Western Railway. I had an opportunity of going to West Drayton on July 27, 1880, so I walked through the cutting towards Langley. My quest was for relics of primæval man, and I was rewarded by finding not only several flint flakes, but the butt end of a massive implement broken in Palæolithic times. This was just north of Langley Station, in Buckinghamshire, and the first Palæolithic relics, as far as I know, detected in that county. The workmen in the cutting for the new canal were such a rough lot that I found it impossible to fraternise with them, so my subsequent visits were all made on Sundays. During these walks I lighted on ten implements and a large number of flakes at Langley and Iver, all in the valley of the Coln, and a river until now (as far as I know) not described as implementiferous. In gravel brought from the pit close to Taplow Station I found a single implement, a large trimmed flake, and numerous simple flakes; this position is also in the county of Buckingham. At West Drayton, in Middlesex, in the valley of the Coln, I lighted on five implements and numerous flakes. East of West Drayton, in a pit near Botwell, in the valley of the Yedding Brook, hitherto undescribed as implement-bearing, I found a single implement; this was in the pit near Bull's Bridge. In the same valley at Hillington, and other places I have found several other implements. In all the excavations from Slough to Acton I have found both implements and flakes. In the new railway cutting from Gunnersbury to Hounslow I have found four implements, one close to Hounslow, a massive butt, and many flakes. This cutting has been a very interesting one, from the abundance of the fossil shells of fresh-water molluscs found in the sands, especially near the bridge under the Hanwell Road. One shell very abundant, and, as far as my observation goes, absent from the sands of North-east London, is *Achatina acicula*, Müll., kindly named for me by Dr. J. Gwyn Jeffreys. I believe this is the first record of fresh-water shells from the Palæolithic sands of the Ealing district. Since my paper on the Valley of the Brent was read before the Anthropological Institute, in June, 1879, I have found many more implements in the positions there mentioned. At North-east London, and especially in the Valley of the Lea, I have been able to greatly extend the range of Palæolithic man. In addition to the localities mentioned in my paper read before the Anthropological Institute, in June, 1878, and published in February, 1879, I am now able to mention London Fields, Homerton, in the south, a position south of Dalston Junction, and nearer the Thames than the places first given by me, Hackney, near the railway station, Abney Park Cemetery, South Hornsey, Highbury, Stamford Hill, Upper Edmonton, Lower Edmonton, Bush Hill Park, Forty Hill, Enfield, and Cheshunt; the pit at the last place, which formerly produced flakes only, has since furnished three implements—one an example of the first class. On the east side of the Lea I have found implements in the gravels of Stratford, Leyton, Leytonstone, Wanstead, Walthamstow, and Higham Hill—a magnificent example from the last place. Further east, and in the Valley of the Roding (first pointed out by me as a river bearing implements in its gravels)—at Barking—I have found two implements, and elsewhere in the neighbourhood, as at Ilford and Upton, numerous flakes. Still further east, at Gray's Thurrock, West Tilbury, and Southend, I have evidence of the presence of primæval man; at the latter place, a rude make-shift implement, and a scraping-tool with twin bulbs of percussion. These were found by my two sons. I have not mentioned all the positions I know in this letter, or re-mentioned those given in my two papers, but rather the positions I can afford to dispense with. It shows, however, especially when considered with the discoveries at Reading and Oxford, what a vast cohort of men once lived all along the Thames and its northern tributaries in Palæolithic times.

WORTHINGTON G. SMITH

125, Grosvenor Road, Highbury, N.

"Halo": Pink Rainbow

THE appearance noted in NATURE this week (p. 268) by Prof. O'Reilly must surely have been a case of the *rayons du crépuscule* that are frequently visible near sundown in the eastern sky. East-south-east cannot at this season be very far from opposite the setting sun. Prof. O'Reilly does not mention, though probably it was the case, that the point of convergence of the "beams" which he saw was diametrically opposite the sun's position. That these beams appeared dark is probably merely caused by the real "rayons" being wide, with narrow, darker interspaces between. I have several times (see *Phil. Mag.*, 1877) called attention to the existence of similar rays crossing the rainbow radially; indeed, it is seldom that a rainbow occurs when the sun is low in the sky, without one or more such rays being visible within the arc. Two such rays, for example, were visible in a bow seen here at sunset two evenings ago. This bow was interesting in another way also; for, like the "pink" rainbows about which there was some correspondence in NATURE last year, the only colours visible (in the primary arc) were red and yellow, the red being of a pinkish rather than a crimson hue.

SILVANUS P. THOMPSON

Pollokshields, Glasgow, July 20

Smoke Abatement

COUNT RUMFORD founded the Royal Institution of Great Britain nearly a hundred years ago, chiefly, I believe, to introduce improved grates, fireplaces, stoves, &c., as he then foresaw the necessity of economising coal and obtaining more complete combustion.

In about the year 1860 Faraday himself showed me Count Rumford's models, &c., and some of Rumford's working stoves in the model room in the Institution, a subject in which I was then much interested, as I was enlarging my own house.

About ten years ago, when the laboratory of the Royal Institution was enlarged, the models, stoves, &c., devised by Count Rumford were removed. It would be important to know what has become of them. Would you kindly allow me to ask this question?

A MEMBER OF THE ROYAL INSTITUTION

July 19

INTERNATIONAL POLAR OBSERVATORIES

ON August 1, it is hoped, that a ring of observing stations will begin work all round the pole. By this time all the expeditions that have been arranged for will either be on the way or on the spot. The readers of NATURE are doubtless familiar with the inception and progress of a scheme for Polar research which originated in 1875 with the late Lieut. Weyprecht, and has been gradually built up until it has assumed the proportions of a great international effort to obtain accurate scientific observations on the physical and biological conditions of the polar area. Our Map of the Arctic Regions will enable the reader to note the localities of the various stations, and the nationality of the observing parties in each case. Meantime it may be useful to give a brief history of the scheme, and a sketch of the programme which it is proposed to carry out. This we are enabled to do from the official documents issued by the International Polar Commission.

As we have already said, it was in 1875, at the forty-eighth meeting of the Association of German Naturalists and Physicists at Gratz that Lieut. Carl Weyprecht explained his views as to the proper basis for Arctic explorations. He showed that while the Polar regions undoubtedly offer one of the most important fields of investigation for all branches of natural science, this is especially the case with reference to inquiries into the physical condition of the earth. The numerous and costly expeditions which have hitherto been organised have, however, yielded comparatively insignificant returns, so that it may almost be said that they have merely contributed to show more clearly how important it would be for all branches of natural knowledge to have those regions explored in a thoroughly scientific way. The scientific results of Polar voyages hitherto have been very scanty, and have borne no proportion to the expenditure of money and labour involved in the expeditions. Weyprecht ascribes this principally to the circumstance that in these Polar voyages geographical discovery was always made the chief object, while scientific investigations were considered to be of secondary importance. He points out also the isolated character of the individual voyages, and consequently of the scientific observations taken during their continuance. The observations are therefore deficient in a qualification which is of great importance in Polar regions, viz. the possibility of a comparison with simultaneous observations at a number of other places. Lieut. Weyprecht therefore proposed to deviate from the principles which have hitherto ruled Polar explorations, by abandoning geographical discovery and particularly reaching the Pole, as the main object, and instead aiming at scientific observations, especially those of a physical character. He proposed that, instead of isolated voyages in the Polar regions, expeditions should be sent out, organised on a common plan, in order to take simultaneous physical observations, for a considerable space of time, at several different points around the Pole.

In conjunction with Count Wilczek, Lieut. Weyprecht drew out a programme for Polar research of this type which was submitted to the International Meteorological Congress, held at Rome in the spring of 1879. The Congress, when this programme was submitted to it, recognised the great importance of Weyprecht's proposals, and recommended it for adoption to all governments. Owing, however, to the fact that all the individual delegates to the Congress had not received definite instructions from their respective governments to deliberate upon such a scheme and to make the necessary arrangements for its execution, the International Meteorological Committee, appointed by the Congress, was instructed to summon a special conference to discuss the subject at Hamburg on October 1 next ensuing.

This conference was attended by nine delegates from the following states:—Austria, Hungary, Denmark, France, Germany, the Netherlands, Norway, Russia, and Sweden. It commenced its operations by the preparation of a detailed programme for the enterprise, and fixed as an indispensable condition of its success, that at least eight points in the Arctic regions should be occupied, and that the interval from the autumn of 1881 to the autumn of 1882 should be the period for the proposed twelve months' observations. The International Polar Conference finally, in order to ensure that due attention should be paid to the necessary arrangement in the different countries, constituted itself as a permanent International Polar committee, with the right of electing new members, and chose Dr. Neumayer as its president.

The second International Polar Conference at Bern in August, 1880, was attended by eight delegates from the same states as before, and in addition by a delegate from Italy, and at its later meetings Prof. Wild, the president of the International Meteorological committee, was present as a member. It appeared from the reports of the delegates that at that time four states had definitely promised participation in the scheme, by occupying stations in the Arctic regions, viz. Austria (Count Wilczek), Denmark, Norway and Russia. The Conference decided to postpone the commencement of operations for a year, *i.e.* till the autumn of 1882, in order to facilitate the timely co-operation of other countries, and the consequent fulfilment of the condition of the occupation of eight stations, which had been fixed by the Hamburg meeting. At this Conference Dr. Neumayer resigned the presidency of the committee, and Prof. Wild was elected to fill the vacancy. This Conference also published its protocols and a condensed report of its proceedings. The President, in May, 1881, announced that the carrying out of the complete scheme, by a sufficient number of observers, was secured by promises of the establishment of at least eight stations in the Arctic regions, and he consequently invited them to the projected third International Polar Conference at St. Petersburg, August 1, 1881.

The third International Polar Conference at St. Petersburg was attended by ten delegates from the States of Austria, Denmark, France, the Netherlands, Norway, and Sweden, of which, however, France and the Netherlands had not yet announced their definite participation in the undertaking, while Russia and the United States had promised to occupy two stations apiece.

Accordingly the Conference finally fixed the epochs of commencement and termination of the simultaneous observations at all stations, and adopted a definite programme for all stations, in as close accordance as possible with the resolutions of the Hamburg Conference, in so far as this appeared necessary for the comparability of the observations.

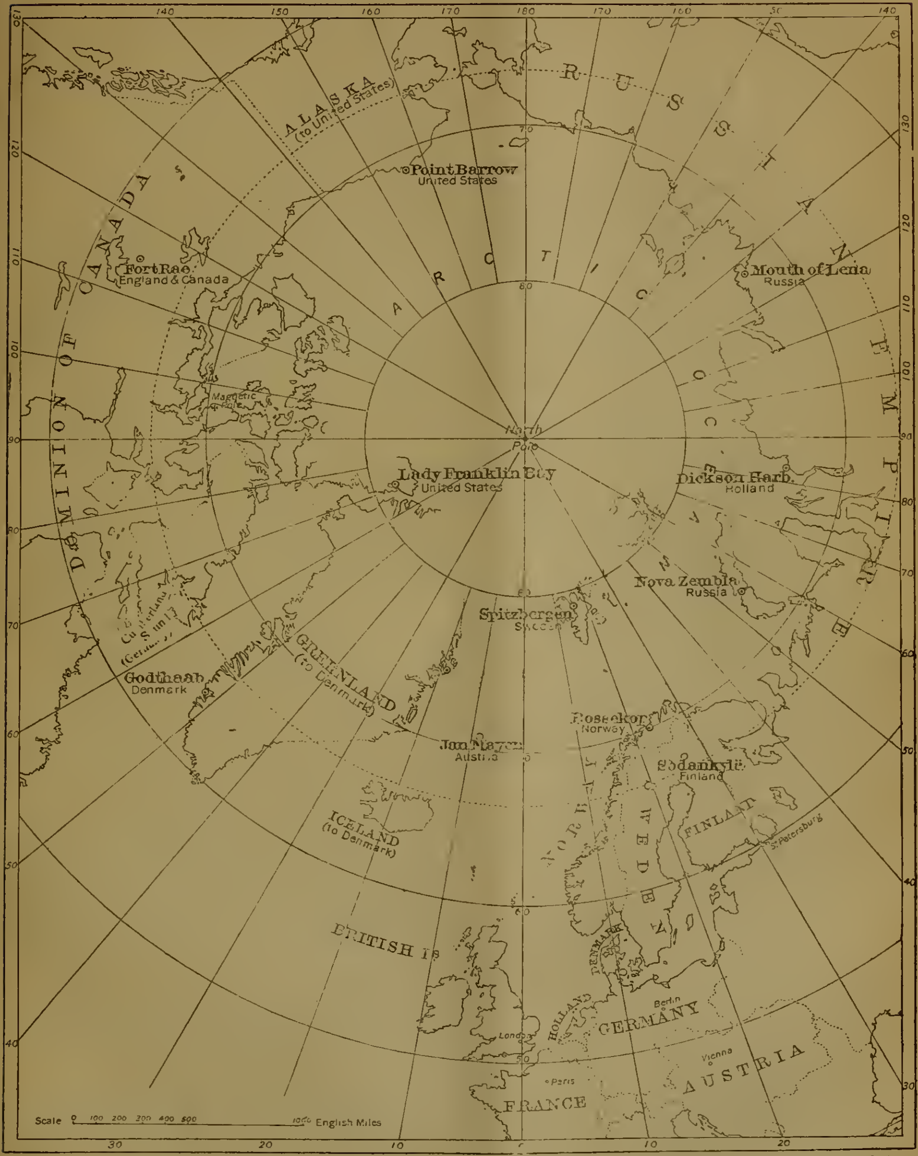
The Conference resolved to request the President and the other members to endeavour to secure that during the period of the Polar expeditions and their observations, the meteorological and magnetical observations in other zones, and the Royal and mercantile navies of each nation should be invited to furnish the data required for preliminary comparison, by more frequent observations, and particularly by observing the variations of magnetic instruments on the term days, and, moreover, that on these days and at times of magnetic disturbances the currents in the various telegraph lines should be specially and carefully studied.

The following is the programme which was adopted at the Conference at St. Petersburg for the observations to be made at the international Polar stations and for their first preliminary discussion:—

I. NECESSARY OBSERVATIONS

a. Beginning and Ending of the Observations

1. The international Polar stations are to begin their observations as soon as possible after August 1, 1882, and end them as late as possible before September 1, 1883.



Stanford's Geogr. Estab.

b. Times of Observation

2. The hourly magnetical and meteorological observations may be made according to any time, only the magnetical observations on the term days must always be made according to Göttingen time (mean civil time). The term days are always the 1st and 15th of every month, except January, where the 2nd is to be taken as the term day instead of the 1st.

c. Order of the Observations

3. The expeditions are free to choose the order of their observations as they think fit.

d. Meteorological Observations

4. Air. Temperature. The mercurial thermometers should be read to 0°·1 C., the spirit thermometers to at least 0°·5 C.

5. The thermometers should be verified at the Central Meteorological Offices, and the spirit thermometers besides are to be compared with a mercurial thermometer at the place of observation at as low temperature as possible. The zero point of all thermometers used in the observations is to be determined afresh from time to time.

6. The thermometers are to be placed at a height of at least 1½ to 2 metres above the ground, in a screen like that given by Wild, and which will secure that without excessive interference with the free circulation of the air about them they will be sheltered from all disturbing influences of radiation.

7. The minimum thermometer for the determination of air temperature must be placed under the same conditions as the other thermometers.

8. The temperature of the sea on the surface and at the depth of every 10 metres is to be observed wherever possible. The following are suggested as useful instruments for this purpose:—sluggish thermometers by Eckmann, Negretti and Zambra, Miller-Casella, &c.

9. Pressure. Every station must at least have a standard mercurial barometer and a good observing mercurial-barometer, besides reserve barometers and aneroids.

10. The barometers must be verified by a Central Meteorological Office, and the observing barometer must be compared at least every week once with standard barometer.

11. Humidity. The psychrometer and the hair hygrometer are to be used, but at low temperatures they must be compared as often as possible with instruments for direct observation.

12. Wind. The vane and Robinson's anemometer should be arranged to be read off inside the observatory (*vide* the arrangement of the Swedish instruments at Spitzbergen). The direction of the wind is to be given for every 16 points and according to true bearings. Its velocity should always be given according to Robinson's anemometer, and also estimated Beaufort's scale. As a reserve instrument for measuring the wind force, in case of injury to Robinson's anemometer, Hagemann's anemometer recommended itself as being simple in management and very strong.

13. Clouds. Form, amount, and direction of motion at various heights, are to be observed to 16 points.

14. Rainfall, &c. Occurrence and duration of rain, snow *Graupel* (soft hail) are to be noted, and when possible the amount.

15. Weather. Thunderstorms, hail, fog, hoar-frost, and optical phenomena are also to be noted.

e. Observations of Terrestrial Magnetism

16. In determination of absolute declination and inclination the accuracy of one minute is to be aimed at, and in those of the absolute horizontal intensity accuracy of 0,001 of its value.

17. It is decidedly necessary, besides the absolute observations in the observatory itself, to make a series of measurements in its neighbourhood, in order to prove the existence of possible local influences.

18. The absolute observations must be conducted in the closest connection and synchronously with the readings of the variation instruments, so as to render it possible to reduce the indications of the latter to absolute value of determination, *e.g.* the absolute zero points of the different scales. The determinations must be made so frequently that any changes which may occur in the absolute value of the zero point of the scale of the variation apparatus may be detected with the requisite accuracy.

19. The observation of the variations should be extended to all three elements of terrestrial magnetism, and it is desirable that every station should have a complete duplicate system of variation instruments so as to make comparative observations from time to time, and to avoid the risk of the interruption of the observations by any accident.

20. The variation instruments should have small needles and the variation of horizontal intensity should be observed at least on one system with the unifilar apparatus with reflectors. Owing to the serious disturbances which may be expected, the scales of the variation instruments should be extended to at least 5° on each side, and as in certain cases deviations may even exceed these limits, the observers must be prepared to be able to measure even such greater excursions. The apparatus should be erected so as to facilitate as far as possible simultaneity of the observations.

21. During the whole time the variations should be read hourly. It is desirable that two readings should be made with an interval of a few minutes, for instance, before and after the exact hour.

22. As term days the first and fifteenth day of each month are fixed (only January 2 instead of 1 is taken); the days are from midnight to midnight, Göttingen time (mean civil time). The readings are to be made every five minutes, and always at the exact minute, and the three elements should be read as quickly as possible one after the other in the following order:—

Horizontal Intensity—Declination—Vertical Intensity.

23. On such term days duriog a whole hour, observations every twenty seconds are to be made, but only of the declination. These increased observations for one hour for the different term days are given in the following table:—

			Göttingen Civil Time,
1882,	August	1	12— 1 p.m.
		15	1— 2 ,,
	September	1	2— 3 ,,
		15	3— 4 ,,
	October	1	4— 5 ,,
		15	5— 6 ,,
	November	1	6— 7 ,,
		15	7— 8 ,,
	December	1	8— 9 ,,
		15	9—10 ,,
1883,	January	2	10—11 ,,
		15	11— Midn.
	February	1	12— 1 a.m.
		15	1— 2 ,,
	March	1	2— 3 ,,
		15	3— 4 ,,
	April	1	4— 5 ,,
		15	5— 6 ,,
	May	1	6— 7 ,,
		15	7— 8 ,,
	June	1	8— 9 ,,
		15	9—10 ,,
	July	1	10—11 ,,
		15	11— Noon.
	August	1	12— 1 p.m.
		15	1— 2 ,,

f. Auroral Observations

24. The auroras to be observed hourly with regard to shape, colour, and motion; the position to be given according to true bearings. The brilliancy of the different parts is to be estimated according to the scale 0—4 (vide Weyprecht: "Instructions for the Observation of Aurora, 1881"). In general, illumination of the aurora is sufficient to read printed matter; its brilliancy is to be estimated in this way and by the method employed in testing eyesight (as, for instance, according to the scale of Jaeger in Vienna).

25. On the term-days, continuous auroral observations will be carried out.

26. Especially remarkable instances of auroras and magnetic disturbances must be made the subject of special investigations, in order to render it possible to determine the connection of the variations of the phases of these two phenomena.

g. Astronomical Observations

27. As as much simultaneity as possible is a main object of the observations, determinations of position and time are to be carried out by instruments erected solidly (universal instrument, transit instrument, &c.), but these are not to exclude the use of good reflecting instruments. Every effort should be made as as quickly as possible to determine the longitude of the place with sufficient accuracy for the objects of expedition.

II. THE OPTIONAL OBSERVATIONS

28. The Conference recommends the following observations and inquiries to the notice of all gentlemen who have either to draw up instructions for an expedition, or themselves to take part in one.

29. Meteorology. The variation of temperature with height; the temperature of the soil, the snow, and the ice on the surface and at various depths; solar radiation; evaporation at all seasons. The melting of ice in the summer.

30. Terrestrtal magnetism. Occasional absolutely simultaneous readings of all three magnetical instruments, so as to determine accurately the relation between the simultaneous variations of horizontal and vertical intensity.

31. Galvanic earth currents. Observations of earth-currents in close connection with magnetic observations and those of auroral phenomena.

32. Hydrographical observations. Observations on currents, on the thickness, structure, and motion of ice, soundings and observations on the physical properties of sea-water, *e.g.* determinations of its temperature and specific gravity. Tidal observations if possible by means of automatic apparatus.

33. Aurora. Measurements of the height of the aurora by two observers stationed about 5 kilometres (3 miles) apart in the line of the magnetic meridian—spectroscopical observations.

34. Observations on atmospheric electricity; on astronomical and terrestrial refraction; on twilight; on the length of the second's pendulum; on the growth and structure of floating ice and of glaciers. The collection of samples of air for analysis.—Observations and collections in the departments of zoology, botany, geology, &c.

III. THE REDUCTIONS AND CALCULATIONS AT THE PLACE OF OBSERVATION

35. The rules adopted by the Congresses of Vienna and Rome are to be followed in all calculations and reductions of meteorological observations.

36. As regards the discussions of magnetic observations the adoption of the metrical units of Gauss is recommended. From the variation observations, the declination, and the horizontal and vertical components of the intensity are to be deduced.

IV.—PUBLICATION OF THE OBSERVATIONS

37. Summaries of the observations are to be sent to the International Polar Commission, as soon as possible after the return of the expedition, so as to be published speedily and in a uniform manner. It is desirable, if possible, to send even earlier notices of the fate and general progress of the expedition.

38. All observations are to be published *in extenso* when their discussion is complete. The International Polar Commission will therefore be reassembled for a fresh Conference, to learn the amount of information which has been obtained, and to come to an agreement as to the best mode of its publication.

39. In this publication the Metric scale will be used, and all temperatures expressed on the centigrade scale.

Nothing could be more complete and satisfactory than this programme, and from the results when reduced and carefully compared, valuable data may be expected as to the physics of the Arctic regions. We trust nothing will occur to mar the success and continuity of the observations, and that they will be such as to encourage their continuance, for we fear that a single year's observations cannot be regarded as furnishing anything like sufficient data to warrant perfectly trustworthy conclusions. The Commission very wisely decided that it would be advisable to obtain series of observations at existing observatories outside the Arctic Area, but as far as possible in the northern hemisphere. To their Circular on this subject they have received favourable answers from the following astronomical and meteorological observatories:—Pola, Munich, Utrecht, Moncalieri, Helsingfors, Breslau, Cordoba (South America), Potsdam, Naples, Lisbon, and Stonyhurst.

At the last moment, the English Government, although they sent no delegate to the Congresses, have decided, we are glad to say, to take a share in the great international undertaking. The following then is a list of the stations, beginning at Behring Strait, and coming eastwards, with the countries whose parties are to occupy them:—

Point Barrow, N.W. Coast Alaska. 71° 18′ N., 156° 24′ W. United States.

Fort Rae, Great Slave Lake. 62° 30′ N., 115° 40′ W. England and Canada.

Cumberland Sound, Davis Strait. 66° 30′ N., 66° W. Germany.

Lady Franklin Bay, N.E. Coast Grinnell Land. 81° 20′ N., 64° 58′ W. United States.

Godthaab, W. Coast of Greenland. 64° 10′ N., 51° 45′. Denmark.

Jan Mayen Island, between Greenland and Norway. 70° 58′ N., 8° 35′ W. Austria.

Spitzbergen. 79° 53′ N., 16° E. Sweden.

Bossekop, N. Coast Norway. 69° 56′ N., 23° E. Norway.

Sodankylå, N. Finland. 67° 24′ N., 26° 36′ E. Finland.

Novaya Zemlya, Karmakulé Bay. 72° 30′ N., 53° E. Russia.

Dickson's Harbour, Mouth of Jenissei. 73° 30′ N., 82° E. Holland.

Mouth of Lena. 73° N., 124° 40′ E. Russia.

Besides these France will carry on observations at Cape Horn, and Germany at South Georgia, on the borders of the Antarctic area; while, on behalf of Italy, Lieut. Bové is co-operating in the Italian Antarctic Expedition.

THE LAY OF THE LAST VORTEX-ATOM

(*Vide* "THE UNSEEN UNIVERSE")

Melody—*Lorelei*

THE Vortex-Atom was dying
The last of his shivering race—
With lessening energy flying
Through the vanishing realms of Space.

No more could he measure his fleeting—
No milestones to mark out his way;
But he knew by his evident heating
His motion was prone to decay.

So he stayed in his drift rectilinear
For Time had nigh ceased to exist,
And his motion grew ever less spinnier
Till he scattered in infinite mist.

But as his last knot was dissolving
Into the absolute nought—
"No more," so sighed he resolving,
"Shall I as atom be caught.

"I've capered and whirled for ages,
"I've danced to the music of spheres,
"I've puzzled the brains of the sages—
"Whose lives were but reckoned by years.

"They thought that my days were unending,
"But sadly mistaken were they;
"For, alas! my 'life-force' is expending
"In asymptotic decay!"

Edinburgh University K.

OUR HEALTH RESORTS[1]

The Scottish Highlands

THE Highlands of Scotland have been rapidly rising in importance during recent years, as affording during the summer and autumn months the most desirable health resorts to professional and business men, as well as to invalids: the most varied scenery, unique as it is picturesque, to the tourist; and the most attractive pleasure-grounds to the sportsman. When it is considered how comparatively unknown to the general run of summer tourists and visitors are the climatic and scenic attractions of large portions of the Highlands, and how

---

[1] See vol. xxv. p. 155.

rapidly the means of transit is being developed, and of accommodation multiplied, it is evident that for some years to come this popularity will continue to grow. These great advantages and attractiveness are due to physical configuration and climate.

As regards climate, the two points to be specially considered are the rainfall and temperature. Of these the most varied, and apparently the most capricious, is the rainfall, which alone imparts to the Highlands very great diversity in its climates.

An annual rainfall of forty inches may be taken as the limit separating the dry climates of the East from the wet climates of the West Highlands. If a line be drawn from Perth to Cape Wrath, all parts of Scotland to the east of it have, roughly speaking, a rainfall not exceeding forty inches, whereas to westward of that line the annual rainfall exceeds that amount. Hence the Eastern Grampians, the Highlands between the Don and Moray Firth, and the Highlands of Eastern Perth, Eastern Inverness, Eastern Ross, Eastern Sutherland, and Caithness are characterised by climates which are comparatively dry, and therefore bracing.

A glance at the map will show that the whole of the Scottish Highlands is, with respect to the west-south-west winds, entirely unprotected by Ireland, and completely exposed to these vapour-laden winds of the Atlantic. Over the whole of Scotland to the south of the Forth and Clyde, which may be regarded as under the lee of Ireland, the average rainfall at no station exceeds 66 inches, with the single exception of Ettrick Pen Top, 2268 feet high, at which fourteen years' observations gave an annual average of 71 inches.

On the other hand, the Highlands to the north of the Clyde are fully open to the west-south-west winds of the Atlantic, and there accordingly the late summer and autumnal rains set in early and with great copiousness. Over an extensive tract resting, as it were, on a base line stretching from Dunoon to Balquhidder, and extending north-westward to beyond Dunvegan, in Skye, the annual rainfall is at least 80 inches. In this extensive region the heaviest rainfalls, and therefore wettest climates are met with in situations either inclosed among mountains of rugged grandeur, such as the districts about Lochs Coruisk, Hourn, and Shiel, or up and over such plateaux as that whence rise the Tay, Leven, Orchy, Aray, and Falloch. The spot of largest rainfall in Scotland, so far as known, is near the head of Glencroe, situated between Lochs Fyne and Long, the mean annual amount there being 128 inches. Surrounding in a somewhat irregular manner this wet district, and stretching northward along the watershed, as far as Loch Assynt, is another region of twice the extent over which the rainfall is from 60 to 80 inches. Again, on the east of this region, and between it and the line marking an annual rainfall of 40 inches, is an extensive tract stretching as far as Cape Wrath, which has a rainfall from 40 to 60 inches annually, and the same rainfall is found in Western Sutherland, a large portion of Western Ross, the whole of the Hebrides, and all islands to the south, the surfaces of which rise to no great height above the sea.

Reference has been made to the shelter afforded by Ireland in imparting a drier climate to places situated to the east-north-east of it The same principle is seen in the influence of Skye and the Hebrides in bringing about the comparatively dry climate of Western Ross and Sutherland, the rainfall of which is from 15 to 20 inches less annually than in similar situations south of Skye, but unprotected from the rain-bringing winds of the Atlantic. Indeed of all places in the west situated to the north of the Crinan Canal, Western Ross and Sutherland enjoy the driest, most bracing, and most desirable climates.

This district has besides an additional advantage, which it possesses along with Skye and Western Inverness-shire during the prevalence of rain-bringing winds from the east. In the east of Scotland the heaviest rains are brought by winds from the east, which are not unfrequently accompanied with a downfall of 2 or 3 inches, or even on rare occasions of 4 inches of rain in a day. The worst and most persistent of these winds, which cause, perhaps, the most disagreeable weather of these climates, owing to the mixture of cold drizzle and rain they bring with them, seldom deposit any rain over the west coast to the north of the Crinan Canal, and over the west of Perthshire. Indeed, on such occasions the weather in the west is almost always marvellously fine, and once enjoyed can never be forgotten, skies of the utmost purity, beauty, and softness, a brilliancy and warmth in the sunshine, a deliciousness in the air, and lights, colouring, and shades towards evening, of such infinite variety and beauty as perhaps no other climate can match.

As regards temperature, the great attraction of the climate of the Scottish Highlands is its comparative coolness, and this coolness becomes, of course, all the greater, the higher we ascend above the sea. As compared with London, the summer temperature of Braemar, for example, during the months of July, August, September, and October, is respectively 8°·9, 9°·0, 9°·1, and 7°·4 lower. The evenings and the nights are proportionally colder than the days. This is the climate which is best adapted for active exercise on the hills and moors. The admirably bracing and other hygienic qualities of the air of places which have comparatively dry climates, and which are 700 feet and upwards above the sea, are everywhere recognised; and it is these qualities which give the upper districts of Deeside, Donside, and Speyside the finest summer climates anywhere to be found in the British islands, particularly for those whose systems require to be braced up for the work of the coming winter. No other district, at these heights and temperatures, which contribute so important an ingredient to the climatic conditions required, can be named, having at the same time accommodation necessary for the comfort of summer visitors, which has not a summer climate essentially wet. The climates of places 700 feet high and upwards in Wales, the Lake District, on the slopes of the Lead and Lowther Hills, and eminently the West Highlands, can only be described as wet in comparison with those of the upper districts of the Dee, Don, and Spey.

Many excellent summer climates, but of quite a different type, are to be found at somewhat lower levels. Among the best of these, omitting sea-side climates, may be named Pitlochrie, Blair Athol, Lairg, Banchory, Dunkeld, Crieff, and Inverleithen, together with Callander and Moffat, the last two, however, being decidedly wetter. The important point to be attended to in selecting summer quarters in the Scottish Highlands is the rainfall, which is really the element of weather on which differences of climate depend; and attention to this point is all the more necessary, since in not a few cases a dry climate and a wet climate are to be found at comparatively short distances from each other.

ON "GETTING" COAL BY MEANS OF CAUSTIC LIME

THE operation of "getting" or breaking down coal from its original position in a seam cannot, in some cases, be effected with a sufficient degree of economy without the aid of blasting. But a certain amount of risk always attends the use of explosive substances, when they are employed for this purpose in fiery mines which are at the same time dry and dusty, unless certain precautions are taken which do not yet appear to be either generally observed or enforced by law. The existence of this danger has long been known, although its causes are only now beginning to be understood; and inventors have been trying to discover some other method of arriving at the same end without producing flame.

Amongst these may be mentioned in this place:—

1. Improvements in wedging processes. A long iron wedge, placed in a previously drilled bore-hole between two strips of iron with flat faces and convex backs, is forced inwards by means of a screw or by hydraulic pressure.

2. Improvements in blasting processes. (*a*) A gunpowder cartridge is placed in an ordinary bore-hole, but a cylinder filled with water occupies most of the remainder of the hole instead of the usual tamping of rubbish (MacNab's Patent). (*b*) A dynamite cartridge inclosed in a waterproof bag is placed *in the interior of the water cylinder* of the last case (Abel's modification).

(The writer conducted a long series of experiments with dynamite water-cartridges for Prof. Abel and the Commissioners on Accidents in Mines, and the results will doubtless be published for the benefit of other investigators. In these experiments the mouth of the shot-hole was always situated in the centre of one side of a cubical bag containing 64 cubic feet of explosive gas.)

3. The caustic lime process, which forms the principal subject of the present note.

Although the proposal to employ caustic lime in this manner is not quite new, its first successful application has been made by Messrs. Smith and Moore, at Shipley Collieries in Derbyshire, where, thanks to the courtesy of these gentlemen, we lately saw it in operation under the superintendence of one of them. The seam of coal which is known as the Derbyshire Deep Hard, consists of three beds in immediate contact with each other. The top bed—one foot thick—is of inferior quality, and is left for a roof and permanently lost. The middle bed—2 feet 10 inches thick—produces good marketable coal in large blocks, and constitutes the object of working. The bottom bed—7 inches thick—together with a bed of soft shale 10 inches thick, serves as a holing. The method of working is longwall—the faces being straight, and each about 100 yards long. The holing is carried in to a depth of about $3\frac{1}{2}$ or 4 feet under the coal; and while it is being done, the front of the mass which it is intended to detach is supported upon short timber props (*sprags*) placed at distances of six feet apart.

After the holing is completed a series of horizontal holes three inches in diameter are drilled close to the roof to a depth of three feet or so. These holes are also about six feet apart. Seven cylindrical blocks of caustic lime, each $2\frac{1}{2}$ inches in diameter by $4\frac{1}{4}$ inches long are placed in each hole. They are prepared by grinding burnt lime to a powder, and then compressing it into blocks of the required shape and dimensions under a hydraulic press. They are, naturally, kept and carried in air-tight boxes. There is a groove in each block parallel with its axis, and large enough to receive a pipe $\frac{1}{2}$ inch in diameter. The grooves are kept uppermost in the bore-hole. An iron pipe $\frac{1}{2}$ inch in diameter, a few inches longer than the length of the hole, provided with a stop-cock at its outer end, and with a cloth bag drawn over its inner end, is inserted into the groove of the first block and then forms a guide for the others. Outside the last block the hole is firmly tamped first with paper, and then with rubbish.

After all the holes have been charged, a quantity of water, said to be equal in bulk to that of the caustic lime already occupying the hole, is forced into each in succession through the iron pipe. This is done by means of a hand-pump attached to a bucket, and provided with a short length of flexible hose. The stopcock of each pipe is immediately closed after the water has been introduced. This operation occupies about one minute for each hole, and the two men who carry it out pass along the face from one end to the other.

A sound as of steam escaping under a high pressure is now heard, and here and there the tamping is blown out. Then follows the well-known sound of what is technically called "working" while the coal is being separated from the upper bed by the pressure of the expanding lime. After the lapse of a few minutes it is found that the whole mass of coal is resting upon the sprags, and these have only to be knocked out in order that it may fall in the face.

The time required for the various operations may be divided as follows:—Drilling, 12 minutes; charging, 4 minutes; introducing water, 1 minute; total, 17 minutes for each bore-hole.

Although this system is undoubtedly successful in the circumstances under which it has been applied, it would be a mistake to assume that it is likely to have anything but a limited application. For it has been found by experiment to be incapable of breaking down a hard rock or shale roof, such as is to be met with in many mines in which blasting is required for that purpose, and for that alone.

Let us take the case of Risca Colliery, so notorious for great explosions, in which the roof of the roadways requires to be ripped down in order to get sufficient height for haulage purposes. The last great explosion took place at the beginning of the present year: but, as only the four men who were underground at the time were killed, it passed almost without remark. Nevertheless, the damage done by it was immense; coal-getting operations had to be suspended for over a month, and one large district of workings was entirely wrecked and was permanently abandoned.

And what were the circumstances under which all this took place? Four men were firing four shots *in the principal intake air-way in the presence of dry coal-dust.* One of these shots blew out its tamping. The men were all found in the intake air-way with their safety-lamps uninjured.

This is a case which the objectors to the coal-dust theory both in this country and abroad would do well to ponder carefully.

WILLIAM GALLOWAY

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA

I.

General Law of Progressive Modification

PETALS are in all probability originally enlarged and flattened stamens, which have been set apart for the special work of attracting insects. It seems likely that all flowers at first consisted of the central organs alone—that is to say, of a pistil, which contains the ovary with its embryo seeds; and of a few stamens, which produce the pollen. But in those plants which took to fertilisation by means of insects—or, one ought rather to say, in those plants which insects took to visiting for the sake of their honey or pollen, and so unconsciously fertilising—the flowers soon began to produce an outer row of barren and specialised stamens, adapted by their size and colour for attracting the fertilising insects; and these barren and specialised stamens are what we commonly call petals.

As the stamens of almost all flowers, certainly of all the oldest and simplest flowers, are yellow, it would seem naturally to follow that the earliest petals would be yellow too. When the stamens of the outer row were flattened and broadened into petals, there would be no particular reason why they should change their colour; and, in the absence of any good reason, they doubtless retained it as before. Indeed, the earliest and simplest types of existing flowers are almost always yellow, seldom white, and never blue; and this in itself would be sufficient ground for believing that yellow was the original colour of all petals. But as it is somewhat heretical to believe, contrary to the general run of existing scientific opinion, that petals are derived from flattened stamens, instead of from simplified and attenuated leaves, it may be well to detail here the reasons for this belief. For if the petals were originally a row of altered stamens set apart for the special function of attracting insects, it would be natural and obvious why they should begin by being yellow; but if they were originally a set of leaves, which became thinner and more brightly coloured for the same purpose, it would be difficult to see why they should first have assumed any one colour rather than another.

The accepted doctrine as to the nature of petals is that discovered by Wolf and subsequently rediscovered by Goethe, who held that all the parts of the flower were really modified leaves, and that a gradual transition could be traced between them, from the ordinary leaf, through the stem-leaf and the bract, to the sepal, the petal, the stamen, and the carpel. Now, if we look at most modern flowers, such a transition can undoubtedly be observed; and sometimes it is very delicately graduated, so that you can hardly say where each sort of leaf merges into the next. But, unfortunately for the truth of the theory as ordinarily understood, we now know that in the earliest flowers there were no petals or sepals, but that primitive flowering plants had simply leaves on the one hand, and stamens and ovules on the other. The oldest types of flowers at present surviving, are certain gymnosperms, such as the cycads, of which the well-known *Zamias* of our conservatories may be regarded as good examples. These have only naked ovules on the one hand, and clusters of stamens in a sort of cone on the other. The gymnosperms are geologically earlier than any other flowering plants. But, if petals and sepals are later in origin than stamens and carpels, we can hardly say that they mark the transition from one form to the other, any more than we can say that Gothic architecture marks the transition from the Egyptian style to the classical Greek. It is not denied, indeed, that the stamen and the ovary are themselves by origin modified leaves—that part of the Wolfian theory is absolutely irrefutable—but with the light shed upon the subject by the modern doctrine of evolution, we can no longer regard petals and sepals as intermediate stages between the two. The earliest flowering plants had true leaves on the one hand, and specialised pollen-bearing or ovule-bearing leaves on the other hand, which latter are what in their developed forms we call stamens and carpels; but they certainly had no petals at all, and the petals of modern flowers have been produced at some later period.


FIG. 1.—Transition from stamens to petals in the white water lily.

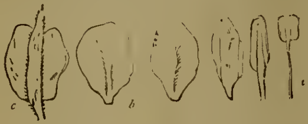


FIG. 2.—Transition from stamen (*a*) to petal (*b*) and sepal (*c*) in flower of double rose.


FIG. 3.—Vertical section of bramble (white).


FIG. 4.—Vertical section of apple blossom (pinky white).

All stamens show a great tendency easily to become petaloid, that is to say, to flatten out their filament, and finally to lose their anthers. In the waterlilies we can trace a regular gradation from the perfect stamen to the perfect petal. Take for example our common English white *Nymphæa alba* (Fig. 1). In the centre of the flower we find stamens of the ordinary sort, with rounded filaments, and long yellow anthers; then, as we move outward, we find the filaments growing flatter and broader, and the anthers less and less perfect; next we find a few stamens which look exactly like petals, only that they have two abortive anthers stuck awkwardly on to their summits; and, finally, we find true petals, broad and flat, and without any trace of the anthers at all. Here in this very ancient though largely modified flower we have stereotyped for us, as it were, the mode in which stamens first developed into petals, under stress of insect selection.


FIG. 5.—Vertical section of dog-rose (bright pink).


FIG. 6.—Vertical section of buttercup (primitive yellow).

"But how do we know," it may be asked, "that the transition was not in the opposite direction? How do we know that the waterlily had not petals alone to start with, and that these did not afterwards develop, as the Wolfian hypothesis would have us believe, into stamens?" For a very simple reason. The theory of Wolf and Goethe is quite incompatible with the doctrine of development, at least if accepted as a historical explanation (which Wolf and Goethe of course never meant it to be). Flowers can and do exist without petals, which are no essential part of the organism, but a mere set of attractive coloured advertisements for alluring insects; but no flower can possibly exist without stamens, which are one of the two essential reproductive organs in the plant.

Fig. 7.—Water crowfoot (white with yellow centre).

Indeed, if we examine closely the waterlily petals, it is really quite impossible to conceive of the transition as taking place from petals to stamens, instead of from stamens to petals. It is quite easy to understand how the filament of an active stamen may become gradually flattened, and the anthers progressively void and functionless; but it is very difficult to understand how or why a petal should first begin to develop an abortive anther, and at last a perfect stamen. The one change is comprehensible and reasonable, the other change is meaningless and absurd.

Fig. 8.—Columbine (bluish purple).

In many other cases besides the waterlily, we know that stamens often turn into petals. Thus the numerous coloured rays of the *Mesembryanthemums* are acknowledged by many botanists to be flattened stamens. In *Canna*, where one anther-cell is abortive, the filament of the solitary stamen becomes petaloid. In the ginger order, one outer whorl of stamens resembles the tubular corolla, so that the perianth seems to consist of nine lobes instead of six. In orchids, according to Mr. Darwin, the lip consists of one petal and two petaloid stamens of the outer whorl. In double roses (Fig. 2) and almost all other double flowers the extra petals are produced from the stamens of the interior. In short, stamens generally can be readily converted into petals, especially in rich and fertile soils or under cultivation. The change is extremely common in the families of *Ranunculaceæ*, *Papaveraceæ*, *Magnoliaceæ*, *Malvaceæ*, and *Rosaceæ*, all very simple types. Looking at the question as a whole, we can see how petals might easily have taken their origin from stamens,

Fig. 9.

Fig. 10.

Fig. 9.—Petal of columbine, secreting honey in its spur. Fig. 10.—Monkshood (deep blue).

Fig. 11.—Petals of monkshood modified into nectaries.

while it is difficult to understand how they could have taken their origin from ordinary leaves—a process of which, if it ever took place, no hint now remains to us.

In a few rare instances, petals even now show a slight tendency to revert to the condition of fertile stamens. In *Monandra fistulosa* the lower lip is sometimes prolonged into a filament bearing an anther: and the petals of shepherd's-purse (*Capsella bursa-pastoris*) have been observed antheriferous.

But if the earliest petals were derived from flattened stamens, it would naturally follow that they would be for the most part yellow in colour, like the stamens from which they took their origin. How, then, did some of them afterwards come to be white, orange, red, purple, lilac, or blue?

The different hues assumed by petals are all, as it were, laid up beforehand in the tissues of the plant, ready to be brought out at a moment's notice. And all flowers, as we know, easily sport a little in colour. But the question is, do their changes tend to follow any regular and definite order? Is there any reason to believe that the modification runs from any one colour towards any other? Apparently, there is. All flowers, it would seem, were in their earliest form yellow; then some of them became white; after that, a few of them grew to be red or purple; and, finally, a comparatively small number acquired various shades of lilac, mauve, violet, or blue.

Some hints of a progressive law in the direction of a colour-change from yellow to blue are sometimes afforded us even by the successive stages of a single flower. For example, one of our common little English forget-me-nots, *Myosotis versicolor*, is pale yellow when it first opens; but as it grows older, it becomes faintly pinkish, and ends by being blue like the others of its race. Now, this sort of colour-change is by no means uncommon; and in almost all known cases it is always in the same direction, from yellow or white, through pink, orange, or red, to purple or blue. Thus, one of the wall-flowers, *Cheiranthus chamæleo*, has at first a whitish flower, then a citron-yellow, and finally emerges into red or violet. The petals of *Stylidium fruticosum* are pale yellow to begin with, and afterwards become light rose-coloured. An evening primrose, *Œnothera tetraptera*, has white flowers in its first stage, and red ones at a later period of development. *Cobæa scandens* goes from white to violet; *Hibiscus mutabilis* from white through flesh-coloured, to red. The common Virginia stock of our gardens (*Malcolmia*) often opens of a pale yellowish green; then becomes faintly pink; afterwards deepens into bright red; and fades away at last into mauve or blue. Fritz Müller noticed in South America a *Lantana*, which is yellow on its first day, orange on the second, and purple on the third. The whole family of *Boraginaceæ* begin by being pink, and end by being blue. In all these and many other cases the general direction of the changes is the same. They are usually set down as due to varying degrees of oxidation in the pigmentary matter.

If this be so, there is a good reason why bees should be specially fond of blue, and why blue flowers should be specially adapted for fertilisation by their aid. For bees and butterflies are the most highly adapted of all insects to honey-seeking and flower-feeding. They have themselves on their side undergone the largest amount of specialisation for that particular function. And if the more specialised and modified flowers, which gradually fitted their forms and the position of their honey-glands to the forms of the bees or butterflies, showed a natural tendency to pass from yellow through pink and red to purple and blue, it would follow that the insects which were being evolved side by side with them, and which were aiding at the same time in their evolution, would grow to recognise these developed colours as the visible symbols of those flowers from which they could obtain the largest amount of honey with the least possible trouble. Thus it would finally result that the ordinary unspecialised flowers, which depended upon small insect riff-raff, would be mostly left yellow or white; those which appealed to rather higher insects would become pink or red; and those which laid themselves out for bees and butterflies would grow for the most part to be purple or blue.

Now, this is very much what we actually find to be the case in nature. The simplest and earliest flowers are those with regular, symmetrical open cups, like the *Ranunculus* genus, the *Potentillas*, and the *Alsineæ* or chickweeds, which can be visited by any insects whatsoever: and these are in large part yellow or white. A little higher are flowers, like the campions or *Silenceæ*, and the stocks (*Matthiola*), with more or less closed cups, whose honey can only be reached by more specialised insects; and these are oftener pink or reddish. More profoundly modified are those irregular one-sided flowers, like the violets, peas, and orchids, which have assumed special shapes to accommodate bees or other specific honey-seekers; and these are often purple and not infrequently blue. Highly specialised in another way are the flowers like harebells (*Campanula*), scabious (*Dipsaceæ*). and heaths (*Ericaceæ*), whose petals have all coalesced into a tubular corolla; and these might almost be said to be usually purple or blue. And, finally, highest of all are the flowers, like labiates (rosemary, *Salvia*, &c.) and speedwells (*Veronica*,) whose tubular corolla has been turned to one side, thus combining the united petals with the irregular shape; and these are almost invariably purple or blue.

The very earliest types of angiospermous flowers now remaining are those in which the carpels still exist in a separate form, instead of being united into a single compound ovary. Among Dicotyledons, the families, some of whose members best represent this primitive stage, are the *Rosaceæ* and *Ranunculaceæ;* among Monocotyledons, the *Alismaceæ*. We may conveniently begin with the first group.

The roses form a most instructive family. As a whole they are not very highly developed flowers, since all of them have simple, open, symmetrical blossoms, generally with five distinct petals. But of all the rose tribe, the *Potentilleæ*, or cinquefoil group, seem to make up the most central, simple, and primitive members. They are simple low, creeping weeds, and their flowers are of the earliest symmetrical pattern, without any specialisation of form, or any peculiar adaptation to insect visitors. Now among the potentilla group, nearly all the blossoms have yellow petals, and also the filaments of the stamens yellow, as is likewise the case with the other early allied forms, such as agrimony (*Agrimonia Eupatoria*), and herb-bennet (*Geum urbanum*). Among our common yellow species are *Potentilla reptans* (cinquefoil), *P. tormentilla*, *P. argentea*, *P. verna*, *P. fruticosa*, and *P. anserina*. Almost the only white potentillas in England are the barren strawberry (*P. fragariastrum*), and the true strawberry (*Fragaria vesca*), which have, in many ways, diverged more than any other species from the norma of the race. Water-avens (*Geum rivale*), however, a close relative of herb-bennet, has a dusky purplish tinge; and Sir John Lubbock notes that it secretes honey, and is far oftener visited by insects than its kinsman. The bramble tribe (*Rubeæ*), including the blackberry (Fig. 3), raspberry, and dewberry, have much larger flowers than the potentillas, and are very greatly frequented by winged visitors. Their petals are usually pure white, often with a pinky tinge, especially on big, well-grown blossoms. One step higher, the cherries and apples (though genetically unconnected), have very large and expanded petals (Fig. 4), white toward the centre, but blushing at the edges into rosy pink or bright red. Finally, the true roses (Fig. 5), whose flowers are the most developed of all, have usually broad pink petals (like those of our own dog-rose, *Rosa canina*, *R. villosa*, *R. rubiginosa*, &c.), which in some still bigger exotic species become crimson or damask of the deepest dye. They are more sought after by insects than any others of their family.

Now, if we look closely at these facts we see that they have several interesting implications. The yellow potentillas have the very simplest arrangement of the carpels in the whole family, and their fruit is of the most primitive character, consisting only of little dry separate nuts. They have altered very little from their primitive type. Accordingly almost all the genus is yellow; a very few members only are white; and these in their habits so far vary from the rest that they have very erect flowers, and three leaflets instead of five or more to each leaf. One of them, the strawberry, shows still further marks of special differentiation, in that it has acquired a soft, pulpy, red fruit, produced by the swelling of the receptacle, and adapted to a safer mode of dispersal by the aid of birds. This group, however, including *Geum*, cannot claim to be considered the earliest ancestral form of the roses, because of its double calyx, which is not shared by other members of the family, as it would be if it had belonged to the actual common ancestor. In that respect, agrimony more nearly represents the primitive form, though its tall habit and large spikes of flowers show that it also has undergone a good deal of modification. Nevertheless, the yellow members of the potentilla group, in their low creeping habit, their want of woodiness, and their simple fruit, certainly remain very nearly at the primitive ancestral stage, and may be regarded as very early types of flowers indeed. It is only among handsome and showy exotic forms which have undergone a good deal more modification, that we get brilliant red-flowered species like the East Indian *P. nepalensis* and *P. atropurpurea*.

But as soon as the plants rise a little in the scale, and the flowers grow larger, we get a general tendency towards white and pink blossoms. Thus the *Pruneæ* have diverged from the central stock of the rose family in one direction, and the *Pomeæ* and *Roseæ* in another; but both alike begin at once to assume white petals; and as they lay themselves out more and more distinctly for insect aid, the white passes gradually into pink and rose colour. To trace the gradations throughout, we see that the *Rubeæ* or brambles are for the most part woody shrubs instead of being mere green herbs, and they have almost all whitish blossoms instead of yellow ones; but their carpels still remain quite distinct, and they seldom rise to the third stage of pinkiness; when they do, it is generally just as they are fading, and we may lay it down as a common principle that the fading colours of less developed petals often answer to the normal colours of more developed. In the *Pruneæ*, again, the development has gone much further, for here most of the species are trees or hard shrubs, and the number of carpels is reduced to one. They have a succulent fruit—a drupe, the highest type—and though the flower contains two ovules, the ripe plum has only one seed, the other having become abortive. All these are marks of high evolution: indeed, in most respects the *Pruneæ* stand at the very head of the rose family, but the petals are seldom very expanded, and so, though they are usually deeply tinged with pink in the cherry (*Prunus cerasus*), and still more so in larger exotic blossoms, like the almond, the peach, and the nectarine, they seldom reach the stage of red. Our own sloe (*P. communis*) has smallish white flowers, as has also the Portugal laurel (*P. lusitanicus*). In these plants, in fact, higher development has not largely taken the direction of increased attraction for insect fertilisers; it has mainly concentrated itself upon the fruit, and the devices for its its dispersal by birds or mammals. In the *Roseæ*, on the other hand, though the fruit is less highly modified, the methods for insuring insect fertilisation are carried much further. There are several carpels, but they are inclosed within the tube of the calyx, and the petals are very much enlarged indeed, while in some species the styles are united in a column. As regards insect attraction, indeed, the roses are the most advanced members of the family, and it is here accordingly that we get the highest types of coloration, Most of them are at least pink, and many are deep red or crimson. Among the *Pomeæ* we find an intermediate type (as regards the flowers alone) between *Roseæ* and *Pruneæ;* the petals are usually bigger and pinker than those of the plums; not so big or so pink as those of the true roses. This interesting series exhibits very beautifully the importance as regards coloration of mere expansion in the petals. Taking them as a whole, we may say that the smallest petals in the rose family are generally yellow; the next in size are generally white; the third in order are generally pink; and the largest are generally rose-coloured or crimson.

Even more primitive in type than the *Rosaceæ* are the lowest members of the *Ranunculaceæ*, or buttercup family, which perhaps best of all preserve for us the original features of the early dicotyledonous flowers. The family is also more interesting than that of the roses, because it contains greater diversities of development, and accordingly covers a wider range of colour, its petals varying from yellow to every shade of crimson, purple, and blue. The simplest and least differentiated members of the group are the common meadow buttercups, forming the genus *Ranunculus* (Fig. 6), which, as everybody knows, have five open petals of a brilliant golden hue. Nowhere else is the exact accordance in tint between stamens and petals more noticeable than in these flowers. The colour of the filaments is exactly the same as that of the petals; and the latter are simply the former a little expanded and deprived of their anthers. We have several English meadow species, all with separate carpels, and all very primitive in organisation, such as *R. acris* (the central form), *R. bulbosus*, *R. repens*, *R. flammula*, *R. sceleratus*, *R. auricomus*, *R. philonotis*, &c. In the lesser celandine or pilewort, *R. ficaria*, there is a slight divergence from the ordinary habit of the genus, in that the petals, instead of being five in number, are eight or nine, while the sepals are only three; and this divergence is accompanied by two slight variations in colour: the outside of the petals tends to become slightly coppery, and the flowers fade white, much more distinctly than in most other species of the genus.

There are two kinds of buttercup in England, however, which show us the transition from yellow to white actually taking place under our very eyes. These are the water-crowfoot, *R. aquatilis*, and its close ally, the ivy-leaved crowfoot, *R. hederaceus*, whose petals are still faintly yellow toward the centre, but fade away into primrose and white as they approach the edge (Fig. 7). We have already noticed that new colours usually appear at the outside, while the claw or base of the petal retains its original hue; and this law is strikingly illustrated in these two crowfoots. White flowers of the same type as those of water-crowfoot are very common among aquatic plants of like habit, and they seem to be especially adapted to water-side insects.

In many *Ranunculaceæ* there is a great tendency for the sepals to become petaloid, and this peculiarity is very marked in *Caltha palustris*, the marsh-marigold, which has no petals, but bright yellow sepals, so that it looks at first sight exactly like a very large buttercup.

The clematis and anemone, which are more highly developed, have white sepals (for the petals here also are suppressed), even in our English species; and exotic kinds varying from pink to purple are cultivated in our flower-gardens.

It is among the higher ranunculaceous plants, however, that we get the fullest and richest coloration. Columbines (*Aquilegia*), are very specialised forms of the buttercup type (Fig. 8). Both sepals and petals are brightly coloured, while the latter organs are produced above into long, bow-shaped spurs, each of which secretes a drop of honey (Fig. 9). The carpels are also reduced to five, the regularity of number being itself a common mark of advance in organisation. Various columbines accordingly range from red to purple, and dark blue. Our English species, *A. vulgaris*, is blue or dull purple, though it readily reverts to white or red in cultivated varieties. Even the columbine, however, though so highly specialised, is not bilaterally but circularly symmetrical. This last and highest mode of adaptation to insect visits is found in larkspur (*Delphinium ajacis*), and still more developed in the curious monkshood (*Aconitum napellus*), Fig. 10. Now larkspur is usually blue, though white or red blossoms sometimes occur by reversion ; while monkshood is one of the deepest blue flowers we possess. Both show very high marks of special adaptation ; for besides their bilateral form, *Delphinium* has the number of carpels reduced to one, the calyx coloured and deeply spurred, and three of the petals abortive ; while *Aconitum* has the carpels reduced to three and partially united into a compound ovary, the upper sepals altered into a curious coloured hood or helmet, and the petals considerbly modified. All these very complex arrangements are definitely correlated with the visits of insects, for the two highly abnormal petals under the helmet of the monkshood (Fig. 11) produce honey, as do also the two long petals within the spur of the larkspur. Both flowers are also specially adapted to the very highest class of insect visitors. *Aconitum* is chiefly fertilised by bees; and Sir John Lubbock observes that "*Anthophora pilipes* and *Bombus hortorum* are the only two North European insects which have a proboscis long enough to reach to the end of the spur of *Delphinium elatum*. *A. pilipes*, however, is a spring insect, and has already disappeared, before the *Delphinium* comes into flower, so that it appears to depend for its fertilisation entirely on *Bombus hortorum*."

(*To be continued.*)

FREDERIC KASTNER

FREDERIC KASTNER, who is known to the scientific world as the inventor of the *Pyrophone*, has recently died, as we announced at the time, at the early age of thirty years. He was the son of an Alsacian composer of some merit, Georges Kastner, and was himself an accomplished musician. Educated partly at Paris and partly at Strasburg, he imbibed a love of science, and at the early age of fourteen years was already assisting his teachers in the chemical laboratory. When seventeen years of age he invented and patented a novel form of electromotor, in which a series of electro-magnets were caused to act in succession upon a rotating arbor. After the war of 1870-71, in which he was driven from Strasburg, he devoted himself to studying the properties of musical flames. The discovery of Higgins in 1777, that a hydrogen flame burning within the lower end of an open glass tube could set up a musical note, had been the starting point of a number of hitherto barren attempts by Schaffgotsch and others. Without knowing anything of the experiments of Schaffgotsch, Barrett, or Tyndall, young Kastner set to work to experiment, with the determination to construct a musical instrument on this principle. For two years he worked at the subject, endeavouring to temper the harsh tones of the flames and to produce a purity and constancy in their notes. He tried tubes of different sizes and forms. He varied the form of the gas jet, and essayed to introduce two or more jets into one tube. At last, in 1871, he discovered that when he employed *two* flames he could control their note at will, being silent when both were close together, but producing sound when they were separated. This phenomenon, which Kastner called the interference of flames, was the real starting-point of Kastner's *Pyrophone* or *Flame-Organ*, which he patented in 1873. This organ had for its pipes glass tubes of different lengths, two hydrogen flames burning in each at the proper height. A very simple lever-arrangement served to separate the flames at will. In this form the instrument was presented to the Académie des Sciences at Paris, and publicly exhibited. Two subsequent improvements followed. A circle of small jets of common coal gas was found to answer quite as well as the two hydrogen jets, the circle being constructed so that by a simple mechanical contrivance it could be increased or diminished in size, thus separating or reuniting the flames at will. The second improvement was the application of electric currents and an electromagnetic apparatus enabling the flame-organ to be played at a distance. The first instrument of this kind constructed by Kastner was in the form of a singing-lustre hung from the chandelier in his mother's house. The pyrophone was shown at the Royal Institution in January, 1875, and at the Society of Arts in the succeeding month. It was also shown at the Loan Collection of Scientific apparatus at South Kensington in 1876, and at the Paris Exhibition in 1878. In 1876, moreover, an account of the instrument and of the researches which led to its construction was published by Kastner under the title of "Flammes Chantantes." The strange, weird tones produced by the instrument attracted the notice of musicians. Gounod sought to introduce the pyrophone into his opera of "Jeanne d'Arc," and Kœnemann at Baden Baden, in 1879, actually introduced the instrument on one occasion. A decline, however, seized the young inventor, whose strength for some years ebbed slowly away, and he died all too soon to see his invention fairly recognised by the public.

THE NEW AFRICAN EXPEDITION

IT is now understood to be quite settled that a new African exploring expedition will start next year. The Royal Geographical Society have, as might have been expected, taken the opportunity of Mr. Joseph Thomson's return from the completion of his engagement to the Sultan of Zanzibar to obtain his services as leader, and it is certain that no bettter selection could have been made.

Mr. Thomson will leave England in the Spring of 1883, and proceed to Zanzibar to organise the expedition. From Mombas, a port on the East African coast, to the north of Zanzibar, he will direct his course straight to Kilimandjaro, and do his best to explore the snowy ranges of this celebrated mountain, which but one European has as yet ever reached. Passing across the water-parting he will then descend through an entirely unknown country to the eastern shore of Lake Victoria Nyanza, and return to the coast by a more northern route, in the course of which it is hoped he may be able to visit Lake Baringo and Mount Kenia—another peak known to run far above the snow-level, but concerning which further details would be very desirable.

As a mere geographical expedition it will be thus seen that the proposed route will be one of great interest, embracing, as it does, the transit through much utterly unknown country, and the exploration of two mysterious snow-crowned mountains, which, according to the usual view of the conformation of the African Continent, appear to be quite out of place in the districts in which they are situated. But still more interesting problems will be solved, if steps are taken to investigate the unknown fauna and flora of Kilimandjaro and Kenia. The animal and vegetable life of these mountains must be entirely different from that of the plains by which they are surrounded. They will prove to have been derived either by modification from the adjacent lower districts, or by immigration from the north—in any case, presenting phenomena of first-rate importance to the student of geographical distribution.

While, however, the Society, which, with its habitual energy, has set on foot the proposed expedition, is ready and willing to do all that is necessary to ensure success in the way of geographical exploration, it does not consider itself bound to undertake the further outlay which the investigation of the natural history of Kilimandjaro and Kenia must necessarily require. To effect this in a satisfactory way, a zoologist and botanist should be attached to Mr. Thomson's staff to make the necessary observations and collections. These gentlemen might perhaps be best left on the upper ranges of Kilimandjaro, while Mr. Thomson descends to the shores of the Victoria Nyanza, to rejoin him on his return towards the sea-coast. However this may be arranged, it is obvious that the addition of two Europeans to the expedition and the transport of their collection from the interior cannot be effected without materially increasing the cost. It is hoped, therefore, that the British Association for the Advancement of Science, which has already been in correspondence with the Geographical Society upon the subject of the proposed expedition, will take up this branch of the question, and at the approaching meeting at Southampton supply the funds necessary for the purpose. It would be a great misfortune if the excellent opportunity of solving a problem of first-rate importance which thus presents itself were to be thrown away for want of the few hundred pounds required to send out naturalists in company with the proposed expedition.

NOTES

WE can only express, for the present, the deep regret with which we learn the death of Prof. F. M. Balfour, a regret which we are sure will be shared by all who know anything of Mr. Balfour's career. The details to hand of the accident which led to Mr. Balfour's death are meagre. The news reached Cambridge on Sunday evening that he had been killed by a fall on the Alps. From later information it would seem that both Mr. Balfour and his guide met with their deaths on the glacier of Fresney, on the south side of Mont Blanc, about five miles west of the village of Courmayeur. The bodies have both been found. Mr. Balfour was only thirty-one years of age.

MR. GEORGE P. MARSH, the venerable American Minister at Rome, whose death, at the age of eighty-one years, has just been announced, was known as the author of the interesting work on "The Earth as Modified by Human Action," reviewed in NATURE, vol. xi. p. 82. His well-known work on "The Origin and History of the English Language" is also marked by a true scientific spirit.

THE German Association of Naturalists and physicians meets this year at Eisenach, from September 18 to 21. In deference to the wishes of many members, the duration of the meeting has been shortened this year by curtailing the festivities which have hitherto held so large a place in the proceedings of this venerable association. The Association, however, will really begin its work on the Sunday evening (September 17) by a "Zusammenkunft im 'Tivoli,'" and finish on the Friday (22nd) by an excursion to Kissingen, the programme including lunch, dinner, supper, and ball. On the 18th, Prof. Haeckel will give a lecture "On the Interpretation of Nature by Darwin, Goethe, and Lamarck"; and on the 21st Prof. Rehmke lectures on "Physiology and Kantism." As the German Association meets quite a fortnight later than our own, there is nothing to hinder English men of science attending both. It is a pity some arrangement could not be come to among the various associations to prevent simultaneous meetings. The English, French, and American Associations all meet this year at the same time; the Americans, at least, might have arranged differently, seeing that their meeting in Montreal next month is intended to be to some extent international.

MR. W. A. FORBES, the Prosector of the Zoological Society of London, has just left the country upon a four month's expedition up the River Niger. During his absence Mr. W. N. Parker has been appointed Deputy Prosector to the Zoological Society. To him all communications should be addressed during Mr. Forbes's absence.

THE United States Government have voted 10,000*l.* for the International Fisheries Exhibition. From the statement made by the Prince of Wales at a meeting of the General Committee last week, it is evident that the arrangements are progressing favourably.

MR. EUGENE OATES, who has been collecting in Pegu for the last fourteen years, is now in England, and has been studying for some months at the British Museum, his intention being to issue shortly a revised catalogue of the birds of Burmah, for which task his personal experiences in the field point him out as being admirably fitted.

MR. WM DAVISON, who is so well known for his collections in Tenasserim and the Malay Peninsula, under the auspices of that energetic ornithologist, Mr. A. O. Hume, is also now in this country. We are glad to hear that Mr. Davison's health is fast becoming restored, and that he hopes soon to be able to return to the scene of his scientific explorations in Malaiasia.

VOL. 1. of a large work on "Electric Illumination" will shortly be published at the office of *Engineering*. The volume refers to general principles, current generators, conductors, carbons, and lamps, the authors being Mr. Conrad W. Cooke, Mr. James Dredge, Prof. O'Reilly, Prof. Silvanus P. Thompson, and M. H. Vivarez; the whole will be edited by Mr. Dredge. A second volume will follow, to comprise installations, motive power, cost of production and maintenance, electrical photometry, secondary batteries, accessories to electric lighting, &c., &c., together with the completion of the patent abridgements from 1872 to 1882.

THE Algerian Government has sent to France a scientific mission to study the means of destroying the Phylloxera. It is mostly composed of viticulturists, apprehensive that the pest may eventually cross the Mediterranean.

"WHENCE comes the x of mathematicians?" is a question on which M. de Lagarde supplies some curious information (in a note to the Göttingen Royal Society of Sciences). The old Italian algebraists named the unknown quantity in an equation, *cosa*, or *res* (which they either wrote out or denoted by a sign). These are translations of the Arabic *šai*, thing, by which the Arabians in Spain indicated the unknown quantity—writing the Arabic equivalent of š; thus our $12x$ would be $\frac{\check{s}}{12}$. Now it has been the rule in Spain to express the Arabic š by the Latin x. Thus our mathematical x seems to have come from the Arabic for thing. Going further back, to the Greeks, it appears that Diophantus called the unknown quantity *ἀριθμός*; and for this, a final sigma, accented, came to be written. It is thought the Arabians may have denoted this by their š, and called it by the name for *thing*. The Greek name for the square of the unknown quantity was *δύναμις*, and for the cube *κύβος*; and the corresponding Arabian terms are clearly derived from these by translation; hence a probability of derivation in the other case (though not by translation).

WE lately noticed a full report on education in the United States, as delineated and reviewed by the Bureau. A later Circular (No. 6) calls special attention to the present teaching of physics and chemistry. The growth of science-teaching, it says, is evident everywhere; and how the movement will culminate, no one can say. To-day, chemistry and physics are taught in nearly all the academies and high schools in the land. Few cities report no teaching; and this circular is an attempt to catch the present aspect of affairs, and to assist and guide them. The supply of science students from the training colleges is increasing fast, and the number of teachers able to give laboratory instruction will soon be equal to the demand. The teaching at some of the older colleges, where the accustomed routine of a classical education cannot be dropped, is among the least satisfactory. The newer schools recognise science as a mental gymnastics and training equal to "Euclid's Elements and the Latin Grammar," always insisting upon the importance of experiment with didactic instruction. In a great majority of cases, nevertheless, mere text-book work is done, and as such work is little else than mischievous cram, our report advises that it be left out in primary and intermediate schools. Far better so, than a long series of lectures listened to term after term; for "three months of laboratory *work* will give more real insight into any science than a whole year's study of the printed page; the latter is like learning language from a grammar, only without attempting to translate or write exercises." It is specially urged, therefore, that the experimenting be done *by the pupils*, and the excellent results of such teaching, even to the youngest learners, are shown in very interesting cases quoted; and the same principle is followed in recommending that apparatus should be extemporised—this also by the pupils especially. "It will be invaluable to the future teacher; it vastly increases his power to interest and instruct his pupils, and at the same time it deepens his own insight into the subjects taught" The value of physical and chemical knowledge to medical men, the inadequate training of many of whom in America we recently noticed, to naval officers, and to women, is specially indicated and enlarged upon. But any such appeal to practical motives is hardly necessary in America, for the complaint is also made that applied science is most in demand, while pure science and research are too commonly ignored.

AT the last meeting of the Anthropological Institute, held at 4, Grosvenor Gardens, the residence of the President, General Pitt-Rivers, F.R.S., who occupied the chair, Lord Talbot de Malahide read a paper on the Longevity of the Romans in North Africa. The author gave several instances of epitaphs and inscriptions on tombs of persons whose age had exceeded 100 years, in some cases an age of 120, 130, and even 140 years had been attained. An interesting discussion ensued in which Mr. Villiers Stuart, M.P., Mr. Moncure Conway, Capt. Cameron, Mr. John Evans, Mr. Francis Galton, Sir Joseph Fayrer, Dr. Allen Thomson, Mr. Carmichael, and the President took part. Capt. R. F. Burton read a paper on some Neolithic Stone Implements and other objects brought by himself and Capt. Cameron from Wásá, on the Gold Coast. A large number of objects were exhibited by the authors and Mr. Ross. General Pitt-Rivers read a paper on the Egyptian Boomerang, and exhibited several specimens. A large collection of Bushman drawings was exhibited by Mr. M. Hutchinson.

A NEW volume of the Classified Catalogue of the Library of the Royal Institution of Great Britain, by Mr. Vincent, the Librarian, is now ready; it includes the most important works published during the last twenty-five years, placed under their respective heads, accompanied by a Synopsis and Indexes of Authors and Subjects.

THE half-yearly general meeting of the Scottish Meteorological Society will be held to-day. The business consists of (1) Report from the Council of the Society; (2) Address by D. Milne Home, of Milne Graden, Chairman; (3) The Rainfall of the British Islands, by Alexander Buchan, Secretary; (4) The Climate of Jerusalem, by Alexander Buchan, Secretary.

IN a paper recently read before the Asiatic Society of Japan, entitled "Religious and political ideas of the early Japanese; beginnings of the Japanese nation, and credibility of the national records," Mr. B. H. Chamberlain (according to the *Japan Mail*), after mentioning the difficulties which beset investigation, and giving an analysis of the religious and so-called historical traditions of early Japan, proceeded to draw, both from the matter itself and from the manner in which it was put together in the histories as we now have them, several conclusions as to the condition of the early Japanese, and the influences which moulded them into the united nation which meets us at the dawn of authentic history. The most important of these conclusions were:—1. That there were three centres of legendary cycles in ancient Japanese, Idzumo, Yamato, and Kinshsiu, and that the country was probably divided into three or even a greater number of states. 2. That instead of having only begun to communicate with the mainland of Asia at about the year 200 A.D., as was commonly supposed, there had never been, so far as we can judge, a time when communication did not exist, and that much of the so-called autochtonous civilisation was really imported, as was proved by a sifting of myths, and even by the test of language, the most archaic form of Japanese, containing a number of Chinese words for implements or ideas that had themselves been borrowed. 3. That authentic history did not in Japan go back farther than A.D. 400, *i.e.* more than a thousand years later than the date commonly accepted for its commencement. Mr. Chamberlain noticed in detail the items scattered through *Kozhiki*, or oldest monument of Japanese literature, relative to the governmental arrangements and religious belief of ancient times, and showed that Shinto was not a religious system properly so-called, but rather a bundle of miscellaneous and often inconsistent superstitions.

DURING a heavy thunderstorm in the Shetland Islands on Tuesday, which lasted several hours, a hill, three miles from Lerwick, was struck by lightning, and huge masses of rock and *débris* were thrown down on the public road which the hill overhangs, filling up the road and the valley at the other side, and suspending traffic. The total weight of the fallen rock is estimated at 400 tons.

LAST week the statue of Mariette Bey, the great French Egyptologist, was unveiled at Boulogne, in presence of a large assembly, including several high officials of the French Republic.

THE report on the proposed grant to the French Minister of Posts and Telegraphs of a sum of 3600*l.*, in view of the meeting of Electricians, has been sent to the French Senate, after having been adopted by the Chamber of Deputies. This meeting will take place only in October. One of the reasons alleged for the delay is the necessity of installing the magnetic instruments now in course of construction for the Observatory of Paris. The assent of the French Senate is stated to be beyond a doubt.

FROM the "Mineral Statistics of Victoria" for 1881 we see that the quantity of gold raised last year was 858,850 oz., being 29,729 oz. more than the quantity obtained in 1880. The deepest shaft in the Colony is the Magdala at Stawell, which is 2409 feet deep.

SOME instructive results have been recently obtained by M. Spring, in studying the dilatation of isomorphous substances (*Bull. Belg. Acad.*, No. 4). He experimented with five alums. These, he shows, expand very regularly, and very little with rise of temperature from zero till a critical temperature is reached (different for each), at which there is rapid expansion, indicating decomposition. Up to 60°, the mean critical temperature, these alums may be said to expand equally, and M. Spring is led to affirm that *isomorphous substances have the same coefficient of expansion*, or at least coefficients very little different. A probable inference is that they have the same coefficient of compressibility; this he has yet to test. Thus, a similarity in physical properties, between isomorphous substances and gases, is suggested; and a law similar to Avogadro's may be applicable, viz., equal volumes of those (isomorphous) substances must contain the same number of molecules. In verification of this is the fact shown by M. Spring, that the quotients of the specific weights of the alums by the respective molecular weights are equal. Thus the law of Avogadro, verified hitherto in its consequences only for gases, may be found to strike its roots even into solid bodies, and the problem of determining the molecular magnitudes of the latter may one day receive a solution conformably to modern theories of chemistry. M. Spring is extending his examination to other isomorphous substances, and will also study the ratio of expansion and contraction in heteromorphous bodies.

THE third instalment of Dr. Hermann Müller's "Further Observations on the Fertilisation of Flowers by Insects" is occupied by observations, supplementary to those recorded in his "Befruchtung der Blumen durch Insekten," on the insects which visit particular species and assist in their pollination, with some notes on corresponding peculiarities of structure in the flowers themselves. It is illustrated by a very beautifully executed plate.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Lady Parkyns; an Egyptian Fox (*Canis niloticus*) from Egypt, presented by Mr. Horace Kemp; two Coypu Rats (*Myopotamus coypus*) from South America, two Common Night Herons (*Nycticorax griseus*), European, presented by Mr. A. A. van Bemmelen; two Californian Quails (*Callipepla californica*) from California, presented by Mr. J. Biehl; a Crocodile (*Crocodilus*, sp. inc.) from Black River, presented by Mrs. A. H. Jamrach; an Æsculapian Snake (*Coluber æsculapii*) from Central Europe, presented by Lord Arthur Russell, M.P.; two Australian Fruit Bats (*Pteropus poliocephalus*), a Black-breasted Peewit (*Sarciophorus pectoralis*), an Australian Monitor (*Monitor gouldi*) from Australia, two Porto Rico Pigeons (*Columba corensis*) from the West Indies, a South American Jabiru (*Mycteria americana*), two Brown Thrushes (*Turdus leucomelas*) from South America, two Demoiselle Cranes (*Anthropoides virgo*) from North Africa, three Blue-shouldered Tanagers (*Tanagra cyanoptera*), a Striated Tanager (*Tanagra striata*), a Tanager (*Saltator*, sp. inc.) from Brazil, two Scops Owls (*Scops asio*) from North America, two Yellow Sparrows (*Passer luteus*) from East Africa, two Beautiful Waxbills (*Estrelda formosa*) from India, purchased; a Two-spotted Paradoxure (*Nandinia binotata*), a Hybrid Sclater's Muntjac (between *Cervulus muntjac* ♀ and *Cervulus lacrymans* ♂), born in the Gardens. The following insects have emerged in the Insect House during the past two weeks:—Silk Moths: *Actias selene*, *Telea polyphemus*, *Telea promethea*; Moths: *Ceratocampa imperialis*, *Bombyx castrensis*, *Zygæna filipendulæ*, *Liparis monacha*, *Deilephila vespertilio*, *Deilephila euphorbiæ*, *Bembecia hylæiformis*, *Plusia concha*; Butterflies: *Parnassius apollo*, *Melanagria galathea*, *Goncopteryx rhamni*, *Vanessa io*, *Vanessa polychlorus*, *Araschnia levana* var. *prorsa*, *Thecla betulæ*, *Thecla spina*, *Epinephele janira*, *Erebia blandina*.

OUR ASTRONOMICAL COLUMN

THE WEDGE PHOTOMETER.—In a communication to the American Academy of Arts and Sciences in May last (NATURE, vol. xxvi. p. 259), Prof. Pickering has some remarks upon the use of a wedge of shaded glass as a means of measuring the light of the stars. He considers that, while it has been maintained by some writers that it is not a new device, "the credit for its introduction as a practical method of stellar photometry seems clearly to belong to Prof. Pritchard, director of the University Observatory, Oxford." Various theoretical objections to this photometer have been advanced, and many sources of error suggested, but Prof. Pritchard has made the best possible reply to them by measuring a number of stars, and showing that his results are in very close agreement with others obtained elsewhere by wholly different methods. His photometer "consists of a wedge of shade glass of a neutral tint inserted in the field of the telescope, and movable, so that a star may be viewed through the thicker or thinner portions at will. The exact position is indicated by means of scale." The measure of the brightness of the star is made by bringing it to the centre of the field and moving the wedge from the thin towards the thick end until the star disappears. Stars must always be kept in the centre of field to insure the readings being comparable. But Prof. Pickering makes the ingenious suggestion that this photometer may be further simplified by substituting the earth's diurnal motion as a measure of the position of the star in the wedge at disappearance. "It is only necessary to insert in the field a bar parallel to the edge of the wedge, and place it at right angles to the diurnal motion, so that a star in its transit across the field will pass behind the bar and undergo a continually increasing absorption as it passes towards the thicker portion of the wedge. It will thus grow fainter and fainter, until it finally disappears." Then the interval of time from the passage behind the bar until the star ceases to be visible becomes a measure of its light, and the time will vary with the magnitude. As in Prof. Pritchard's form of the instrument, it is only necessary to determine the value of a single constant. Prof. Pickering adds some suggestions with regard to observations with this photometer, and recommends them to the attention of amateurs.

THE OBSERVATORY IN YALE COLLEGE, U.S.—Prof. H. A. Newton, who was appointed Director of the Winchester Observatory in Yale College, New Haven, U.S., in May last, has drawn up a report on the present state of this establishment, and of the preparations in progress for placing the instruments in new buildings specially erected to receive them. The heliometer ordered from Repsold, of Hamburg, two years since, was received last spring; the cost, including freight, and other expenses to New Haven, being close upon 7460 dollars. To supplement the heliometer, and also for independent work, an equatorial telescope of 8 inches diameter was ordered from Mr. Howard Grubb of Dublin, and is expected in August. (No mention is made by Prof. Newton of the 9-inch Alvan Clark refractor, which Yale College was stated to possess in the Smithsonian report on astronomical observations in 1880). About nine acres from the southern extremity of the observatory lands have been set apart as a site for the observatory, and the erection of two towers for the heliometer and equatorial respectively, has been commenced. The heliometer tower was expected to be ready for the instrument early in July, the dome constructed by Mr. Grubb having been already put in place. It is intended by Prof. Newton to undertake such work with it, immediately it is available, as shall prepare for the most advantageous use of the instrument during the approaching transit of Venus. In the Smithsonian report referred to, the diameter of the object-glass is stated to be 6 inches.

The income derived from the fund set apart by the late Hon. O. F. Winchester, is to be applied for the maintenance of the observatory. The 8-inch equatorial has been purchased from funds generously provided by a private individual, who for the present does not desire his name to be mentioned. Under the direction of Prof. H. A Newton, supported by such liberality, astronomers will look forward to a bright future for the "Observatory in Yale College"—as, with the assent of Mr. Winchester's family, the institution is to be called.

THE TRANSIT OF VENUS.—In consequence of the sudden death of Mr. Burton, who, as we mentioned last week, had been appointed observer at Aberdeen Road, Cape Colony, we understand Mr. A. Marth will have charge of that station.

It is not improbable that some readers may contemplate proceeding for the purpose of observing this phenomenon (which will not recur till the year 2004), where it is visible from ingress to egress, and perhaps with a view at the same time of escaping a winter in this climate. If such there be, they might not readily fix upon a more advantageous station than the Blue Mountain range in the island of Jamaica or its vicinity. Calculating for a point in longitude 77° 30′ W., latitude 18° 5′ N., the times of contacts and sun's altitudes are as follows:—

		Local mean time.	Sun's altitude.
		h. m. s.	° ′
First external contact,	Dec. 6	8 52 37 a.m.	30 15
,, internal	,, ,,	9 13 23 a.m.	33 54
Last internal	,, ,,	2 39 5 p.m.	32 17
,, external	,, ,,	3 0 22 p.m.	28 29

WELLS' COMET.—The following places of this comet are for Greenwich midnight :—

	R.A.	Decl.	Log. distance from	
	h. m. s.	° ′	Earth.	Sun.
July 27	11 39 1	+5 58·7	0·2614	0·1380
29	11 44 41	5 38·3	·2732	·1506
31	11 50 5	5 18·5	·2867	·1626
August 2	11 55 14	4 59·3	·3004	·1742
4	12 0 9	4 40·6	·3126	·1853
6	12 4 51	4 22·7	·3244	·1960
8	12 9 22	4 5·2	·3358	·2064
10	12 13 43	3 48·2	·3469	·2164
12	12 17 54	3 31·7	·3576	·2260
14	12 21 56	+3 15·7	0·3680	0·2354

The calculated intensity of light on August 9 is equivalent to that at the first Harvard College observation on March 19.

COMET-SEEKING IN THE SOUTHERN HEMISPHERE.—From a communication to the *Sydney Morning Herald*, we learn that Mr. Tebbutt, of Windsor, N.S.W., the discoverer of the great comet of 1861, has, at the instance of the Boston (U.S.) Scientific Society, undertaken the organisation of a corps of amateur comet-seekers in Australia, and with this object has addressed a circular to several persons in the colonies, who have manifested an interest in the science. We wish Mr. Tebbutt every success: the matter could not be in better hands. It would be easy to adduce numerous cases where the theories of these bodies have suffered from the want of southern observations, and it may be hoped, that in conjunction with the systematic search undertaken by a number of observers in America, and, we are glad to add, in this country also, it will be quite an exceptional case for a comet within range of ordinary telescopes to escape detection, as we know many have done in past years. The additions to the number of comets of short period during the last fifteen years, are alone a sufficient inducement to institute more systematic examination of the heavens in future.

PHYSICAL NOTES

AN organ-pipe sonometer is described in the *American Journal of Science*, by Mr. Le Conte Stevens. The ordinary resonance box of the sonometer is in this instance replaced by a double organ-pipe of spruce fir-wood, tuned to give the note $C=132$ vibrations. Three steel wires are stretched above, two being tuned to the fundamental, the other strained to various degrees of tension by a lever and a sliding weight. There are also arrangements for sharpening or flattening the note of one of the pipes at will, so as to produce beats. By varying the wind-pressure, the natural harmonics of the pipes can be produced. The object of the instrument is to afford a convenient means of producing the notes of the natural scale and those of the tempered scale, by way of contrasting them with one another. The apparatus has several other uses as a lecture instrument in acoustics.

M. CAILLETET has invented a new pump for compressing gases to a high degree of compression. The main point in its construction is the method by which he obviates the existence of useless space between the end of the piston-plunger and the valve, which closes the end of the cylinder. This he accomplishes by inverting the cylinder and covering the end of the plunger with a considerable quantity of mercury. This liquid piston can of course adapt itself to all the inequalities of form of the interior space, and sweeps up every portion of the gas, and presses it up a conical passage into the valve. The valve by which the air enters the body of the pump is opened by a cam-gearing after the descent of the piston below point where the air rushes in.

ANOTHER suggestion due to M. Cailletet is worthy of notice, and is applicable to many pieces of laboratory apparatus beside air-pumps. It is the employment of *vaseline* as a lubricant wherever there is a liability of the presence of mercury; for, as is known, most oils and fatty matters clog with finely-divided mercury, and are objectionable on this account.

NEW forms of secondary battery continue to make their appearance, most of them based upon the accumulator of Planté. Mr. R. E. Crompton has lately patented a process for giving a large effective surface to the leaden electrodes by making it porous, by adding to the lead some other substance capable of being extracted by the action of acid, or by heat, or by other reagents. Another modification due to Messrs. Biggs and Beaumont, consists in collecting in a separate vessel the hydrogen or other products of decomposition, in the accumulator, the collected products being afterwards recombined as fast as required. The electrodes in this case are composed of finely divided lead.

WE have also received a report of a lecture delivered by M. Maurice Lévy before the Societé d'Encouragement on the same subject of electrical units. It speaks volumes for the mathematical education given in the public schools of Paris, if an audience of a society comparable to that of our Society of Arts could follow the lecturer through a mathematical discussion like that before us, which includes a discussion of the doctrine of dimensional equations, and of the elimination of arbitrary coefficients. M. Lévy applauds the decisions of the Congress, which he expounds logically and elegantly.

THE following experiment of Messrs. Jamin and Maneuvrier illustrates the presence of an inverse electromotive force in the voltaic arc, dependent on the actions therein excited by the current. A continuous current was passed first from coke to mercury, producing a reddish coloured arc. The current was then reversed, when the arc appeared green, and the metal volatilised rapidly. Then the current of an alternating Gramme machine was passed through the same arrangement. The arc now appeared green, showing a predominance of the current from mercury to coke, although in ordinary circumstances the two alternately directed currents are absolutely equal in strength.

THE decisions of the Electrical Congress have aroused the electricians of several Continental nations to realise the advance in exact science which the adoption of a uniform system of electrical units implies; and not to be behindhand, they are striving to spread a knowledge of what has been done. The new determination which is to be made of the value of the ohm has furnished material for several discussions, in which it is curious to observe the suggestions that were brought forward as new. Others content themselves with expounding that which has been already done. We have before us, from the pen of Dr. Guglielmo Mengarini, assistant in the Physical Institute of the University of Rome, a "History of the Electromagnetic Unit of Resistance," reprinted from the official bulletin of the Minister of Public Instruction. Beginning with the work of Davy, Becquerel, Ohm, and Wheatstone, the author describes how gradually the rheostat brought forth the resistance-coil, and the units of Siemens and of the British Association. He then gives a theoretical discussion of the absolute electromagnetic unit of resistance, and an account of the methods of Weber and of the British Association for determining it. The main points in the propositions submitted to the International Congress at Paris in 1881 are then given, together with the formal decisions of the Congress thereupon.

A VALUABLE contribution to the subject of the electricity of flame has been lately made by Herren Elster and Geitel (*Wied. Ann.* No. 6). The discrepancies in previous results are attributed largely to the behaviour of the air layer immediately outside of the flame having been left out of account. The authors used a Thomson quadrant electrometer for measurement. They find the supposed longitudinal polarisation of flame merely apparent, and due to unequal insertion of the wires used as electrodes. On the other hand, flame is strongly polarised in cross section; an electrode in the air about the flame is always positive to one in the flame. The theory the authors adopt is this:—By the process of combustion *per se* free electricity is not produced in the flame; but the flame-gases and the air-envelope have the property of exciting, like an electrolyte, metals or liquids in contact with them. To this electrolytic excitation is added a thermo-electric, due to the incandescent state of the electrodes. The amount and nature of the electric excitation is independent of the size of the flame, and dependent on the nature, surface-condition, and glow of the electrodes, and on the nature of the burning gases. *Inter alia*, it is remarked that flames may be combined in series like galvanic elements, and so as to form a "flame-battery."

IN a recent dissertation (*Wied. Ann.* No. 7), Herr Heine describes experiments on the absorption of heat by gas-mixtures with varying percentage of constituents, and he thence deduces a method of ascertaining the amount of carbonic acid in the air. Varied mixtures of CO_2 and air, in known proportions, were formed in a tube to which the heat of a Bunsen burner was admitted (through a rock-salt plate); and the resultant variations of pressure were recorded by means of a Knoll pantograph. The curve obtained (with percentages as abscissæ and indicated pressures recorded as ordinates) shows, as one might expect, a decrease of rise of pressure through absorption of heat, with decrease of CO_2, but the two are not proportional. With regular decrease of CO_2 from 100 per cent., the fall is slight, in the curve, to about 5 per cent., and thereafter rapid to zero with pure air. (Mixtures of CO_2 and H gave a different curve, with a much lower position throughout.) By chemical methods the CO_2 has been shown to vary between 0·02 and 0·05 per cent. Hence it was desirable to develop the corresponding part of the curve just described with special care. This was done, and atmospheric air, freed from moisture, but not from CO_2, was admitted to the apparatus. The tabulated results of fifty analyses made thus, in four days, at Giessen, appear to prove the applicability of the method. (The proportion of CO_2 varied between 0·020 and 0·034.) Its advantages are: only small quantities of air (one or two litres) being required, and the operations being quite simple, and taking little time (say half an hour). It is suggested that the aqueous vapour in air may be similarly measured.

A THIRD instalment of researches on transpiration of vapours, by Herr Steudel, at the instance of Prof. Lothar Meyer, is described in *Wied. Ann.* No. 7; it relates to alcohols and their halogen derivatives, and to some substitution-products of ethane and methane. In a concluding paper Prof. Meyer reviews the inquiry. The supposition is confirmed, that homologous series, even with very different molecular weight, have for the most part nearly the same constants of friction. (All compounds containing one carbon atom show strong divergence.) The influence of the nature of the contained atoms, on friction, is remarkable. Thus, with about equal molecular weight, iodine produces a much greater friction than bromine, and the latter a greater than chlorine. Far-reaching conclusions as to the form of molecules, Prof. Meyer is not prepared to draw, but the cross section of the molecule of a tertiary butylic compound is inferred to be less than that of the corresponding secondary, and the latter less than that of the primary. This agrees with received views as to the linking of these compounds. The molecular volumes reckoned from the friction of vapours, stand to each other in nearly the same ratios as the molecular volumes in the liquid state at boiling point.

FROM observations made several years ago, Prof. von Reusch of Tübingen was led to think the hydrophane of Czernowitza a substance peculiarly well fitted for diffusion experiments with gases. Its properties in this relation have now been carefully studied by Herr Hufner (*Wied. Ann.* No. 6); and *inter alia*, it is shown that the resistance to passage of a number of gases is related both to the coefficients of absorption and the specific gravities; all three increasing in the same sense (but not in simple proportion).

AN interesting analogy to thermoelectric phenomena, &c., is given by M. Bouty in the *Journal de Physique* (June). Suppose a tubular ring, impermeable to heat, containing in its lower half sand saturated with water, and in its upper air saturated with water-vapour. If heat be applied at one end (A) of the sand, a circulation is set up, the water being vaporised at A, condensed at the opposite end B, and filtering through the sand to replace the water evaporated at A. Again, suppose (instead of heat) a rotary pump acting about the middle of the air space; a circulation is produced, and the water evaporating at A causes a fall of temperature, while the condensation at B causes a rise; an image is thus presented of Peltier's phenomenon. The junction A, which is cooled, is precisely the one which must be heated to produce the existing circulation, and the quantity of heat absorbed at A is proportional to the weight of water evaporated per second, that is, to the intensity of the current.

SIGNOR MARTINI (*N. Cim.* [3] 9, 1881) obtains diffusion figures thus: A glass vessel is filled with two liquids little differing in density, *e.g.* water and an aqueous solution of salt or sugar. They are left at rest for an hour. A capillary tube entering the bottom of the vessel is connected by caoutchouc tubing with a movable vessel of coloured alcohol. When the latter enters by the capillary, it rises as a thin spiral thread, but on reaching the lighter liquid it spreads into fine tree-shaped figures. Figures of umbrella shape are produced, if the heavier liquid be used in place of the alcohol.

PROF. T. C. MENDENHALL, of Columbus, Ohio, communicates to the *American Journal of Science* a paper on the Influence of Time on the Change of Resistance of the Carbon Disk of Edison's Tasimeter. This resistance was found, when pressure was removed suddenly, to return to its maximum value; but when pressure was applied, time was necessary to enable the resistance to reach its minimum. On applying pressure, the resistance fell a little more than 3 per cent. in one minute, about 5 per cent. in three minutes, and about 10 per cent. in one and a half hours.

CONTRARY to the opinion now generally received concerning the alleged change of resistance of carbon under pressure, Mr. Mendenhall, in the communication alluded to in the preceding note, asserts that the effect is not due to better surface contact. His own experiments were made with one of Edison's compressed lampblack buttons resting in its place in the tasimeter, and covered by an "upper contact piece." This is all the information given upon this vital point of how the contacts were made, and in the absence of any evidence of care or precautions to ascertain whether the contact was perfect or not, the opinion pronounced must be regarded as worth very little.

GEOGRAPHICAL NOTES

THE *Journal* of the Straits Branch of the Bengal Asiatic Society for December, 1881, contains a short comparative vocabulary of the Fijian and Maori (New Zealand) languages, with notes by Mr. Thurston and Sir F. A. Wild. The Maori is a recognised member of the Eastern Polynesian linguistic family, and from these specimens the Fijian might be supposed to belong to the same connection. But the natives, especially of the eastern islands of the Fiji Archipelago, have long been exposed to Polynesian influences, through their relations with the Tonga islanders. These influences are apparent both in their physical type and in the numerous dialects current on the coast. But the skulls of the Kai Colos occupying the interior of Viti Levu have been shown by Prof. Flower to be of a distinctly Papuan character. In fact, they are the most dolichocephalic on the globe. The outward appearance of the Kai Colos and other tribes removed from contact with the Tonga people also closely resembles that of the pure Melanesians of the New Hebrides and Solomon groups. Specimens of their speech have not yet been collected; but it may be taken for granted that it will be found to be of a distinctly Melanesian type, betraying little or no affinity to the Polynesian. Such vocabularies as these, while possessing a certain value, are apt to be very misleading, and have in fact contributed to the current belief that the Polynesian and Melanesian tongues are fundamentally one. In reality they possess nothing in common beyond the verbal resemblances due to the wide-spread Polynesian influences in the Melanesian domain. In their morphology and inner structure, the two systems are radically distinct.

HIRT, of Breslau, has published a second part of the "Geographische Bildertafeln," by Dr. Oppel and Herr Arnold Ludwig, the first part of which we noticed recently. This part is devoted to typical landscapes, and the selection seems to us to have been made with great discrimination. For Great Britain, for example, we have Loch Ness in Scotland, a Scotch Moor, the Giants' Causeway, the Dover Coast, a Welsh Valley, and an extensive landscape on the Upper Thames. All the other leading countries of Europe are treated after a similar fashion, while representative scenes are given from the great divisions of the other continents. The interest and utility of such a collection are obvious. The same publisher issues also a coloured panorama, showing the chief forms of the land and water on the surface of the globe, much superior to the publications of the same class with which we are familiar in this country.

LIEUT. GIRAUD has sailed from Marseilles for Zanzibar, as leader of a French expedition which proposes to take up African exploration where Livingstone laid it down with his life on the south shore of Lake Bangweolo. Lieut. Giraud proposes to go either direct west to Lake Tanganyika, or, more probably, by the north shore of Lake Nyassa, to the Chambeze River. This he will follow to its outlet in Lake Bangweolo, which he proposes to circumnavigate. He will then attempt, in canoes, to sail down the Luababa-Congo, to its mouth in the Atlantic Ocean. This is an ambitious programme; and every one interested in African exploration will wish the expedition complete success.

THE current number of the *British Quarterly Review* contains an article on recent Japanese progress, which is by far the most valuable that has been published on this subject for many years past. The author, Col. H. S. Palmer, R.E., describes fully the causes and course of the changes which have passed over the "Land of the Rising Sun" in the past fourteen years; the various and complicated changes in the constitution and administration—from the pure oligarchy which succeeded the revolution of 1868, to the system of tolerably free local government of the present day—are clearly explained, and the effect of the various steps in these changes made comprehensible to the general reader. The writer then takes the recent reforms under various heads—the army, navy, education, public works, prisons, &c.—and shows, by statistics, what advance has really been made. The last half of the paper is, in fact, a comprehensive summary, with running commentary, of the Japanese government statistics in every department. The knotty subject of finance is treated with as much clearness as the subject admits of. Under this head the almost inevitable character of the present financial depression is explained; but it is gratifying to notice that a careful and impartial observer like Col. Palmer is able to conclude his article with confidence in the future of the country to which he has devoted so much study. Many of the interesting statistics in the paper have already appeared in the columns of NATURE.

DR. HOLUB has sent us several papers connected with his South African explorations. There are two on the English in South Africa, from the standpoint of exploration and civilisation, and a similar paper on the French in Tunis; and an interesting Catalogue, with notes, of Dr. Holub's ethnographical collections.

IN connection with Egyptian troubles, Mr. Wyld has published two maps, which may be useful to those who are watching operations. One is a plan of Alexandria and the harbour, with an inset map showing the British possessions in the Old World; the other is a small map of the Isthmus of Suez and Lower Egypt, on the scale of twelve miles to an inch, with a similar inset map.

CONTRIBUTION OF ASTRONOMY TO THE PROBLEM OF MOLECULAR PHYSICS[1]

THE kind way in which you have received me, leads me to fix, by writing, the principal points of our conversation on Sunday last. I thank you heartily for offered help to realise the scientific aim I have in view, and which I will now explain.

The synthetic study of thermo-chemical phenomena, of the laws of thermo-dynamics and of experiments relating to these subjects of the physical sciences, has brought us to consider the *temperature* of a body as being the *mean amplitude* of the vibratory oscillation of molecules constituting that body.

This definition, taken as a starting point, enables us to explain and deduce all the essential laws of the mechanical theory of heat. We obtain from it easily the law of Dulong and Petit, that of isomorphism in systems of crystallisation, the relations connecting the coefficients of expansion of all substances with their atomic weight, their temperature of fusion and their density, &c.

The maximum tensions are calculated in advance with all exactness, and lastly, the two great mechanical principles of heat are an immediate and necessary consequence of it.

I have, then, every reason to believe that this definition will be adopted, since it satisfies as well the condition of integrability of the differential equation of motion (function S of Zeuner) as the definition drawn from the air or mercury thermometer (definition of Regnault).

In that case, what is the *specific heat* of a body?

The specific heat becomes the sole manifestation of the *attraction* of molecules for one another.

Indeed, if we multiply the *space traversed* (temperature) by the *molecular force* (specific heat), we obtain the total heat or quantity of absolute work which the substance contains.

Here, consequently, comes in an important question, which is by no means secondary, as has often been said—

Is the attraction of matter for matter a fundamental essential property of matter, or is it merely the result of the dynamical action of the medium in which the matter exists?

In other terms, may one say, without its being possible to explain it, Matter attracts matter without the active intermediary of the medium; or, Attraction as a *force* does not exist; it is merely the manifestation of shocks of the ether which tend to approximate bodies according to the Newtonian law?

In the former case, one regards the *attractive potential* of matter as an original capital placed in each material element, a capital which is only exhausted by the absolute approximation of all matter existing in the universe. In the latter case this potential is *nil*, and one supposes that a certain quantity of kinetic energy has been communicated in the beginning of time to the mass of the universe, a quantity of energy which is inevitably transformed under a thousand different combinations into all the physico-chemical and astronomical phenomena of nature.

In the former case $\frac{1}{2} mv^2$ + *the potential is constant.*

In the latter, $\frac{1}{2} mv^2$ *alone is constant.* The solution of this important question is necessary to establish physical theories in a somewhat distinct manner, and to prove the intimate relation existing between the various elements of bodies.

On the hypothesis that *attraction* is an essential property of matter, we shall liken it to *inertia*; thus any body will possess as primordial characters, a certain quantity of inertia, without which we should never come to be put in contact with it nor to know it, and a certain quantity of *attraction*, which will be the manifestation of its proper influence on the rest of the universe. Such will be the conditions of existence of matter.

On the hypotheses that $\frac{1}{2} m v^2$ alone is constant, *inertia* and *motion* are the fundamental properties of matter; *shocks* are the means of transformation of different modes of motion.

Let us take, then, any body and heat it.

If we are partisans of the first hypothesis, that of *potential*, we must expect to find simple relations between the *inertia of the body considered, the attraction of the molecule for one another, and increase of volume of the body*, the whole associated with the quantity of mechanical work furnished to the body in the form of heat.

The *specific heats* and *latent heats* will then be functions of the *atomic weight* or *inertia* of the body, and the dissociation which is manifested by *fusion* and *volatilisation*, will be deduced from the study of the body under these two aspects, masses set in motion, and *potential* of those masses.

If we are partisans of the second hypothesis, supposing that $\frac{1}{2} m v^2$ is constant, we are obliged simply to consider the volume of the body; that is to say, the exterior surface of the smallest quantity of matter.

Indeed, shocks alone explain the phenomena. But when one says *shock*, he says *surface* where the shock occurs. The greater the surface the larger the number of shocks of the ether, the stronger the reaction of the matter.

We must expect them, in this second hypothesis, to find simple relations between the volumes of atoms and of molecules, that is, between the co-efficients which represent the density of the bodies, the number of atoms and the atomic weight, and the specific heats, latent heats, and maximum tensions.

In other terms, in the first hypothesis, molecular physics will rest essentially on the *atomic weight*, which, by virtue of the fall of bodies, represents simultaneously the idea of *inertia* and that of *attraction*, essential properties; in the second hypothesis the physico-chemical phenomena are deduced mainly from the *volume* of atoms and the *medium* in which the phenomena occur.

The *medium* becoming *active*, a variation of medium will induce in phenomena of attraction concomitant variations quite independent of matter itself.

The *specific heats* and the *latent heats* may then be variable elements in the same substance and *at the same temperature* under the same pressure, according to the *mechanical energy of the medium* in which the phenomena occur.

Thus the whole of molecular physics is closely connected with the solution of this theoretical question.

We have sought an experimental method capable of throwing some light on this problem. Without entering into too minute details, we will explain the plan of this work.

It may be accepted, I believe, that the solar system is nearly independent, mechanically speaking, of the rest of the universe; that is to say that no motion, relatively to the centre of gravity of this system, is produced in our planets by the perturbation of other systems surrounding us.

We may then call M the total mass of the solar system. This mass is decomposed into m, m^1, m^2 . . . the respective masses of the Sun, Venus, the Earth, Jupiter, &c., and μ the mass of

---

[1] A letter from M. Raoul Pictet to M. Dumas, dated Paris, December 16, 1881, and published in *Archives des Sciences*, June 15.

the ether, whose density is function of the velocity of propagation of light and heat, as also of the wave-lengths.

Multiplying all these masses by the square of the velocity of each particle relatively to the centre of gravity of the solar system, we obtain the factor $\frac{1}{2} Mv^2 =$ the total kinetic energy of the solar system.

This constant kinetic energy (if the second hypothesis be admitted, in which $\frac{1}{2} m v^2$ is constant) is not distributed throughout the solar system in a regular and fixed manner. Sometimes a planet, as Jupiter, is at the extremity of the larger axis of his ellipse, and advances more slowly; sometimes, on the contrary, his velocity is accelerated and passes through a maximum to another position of his orbit.

At the same minute all the planets are revolving round the sun, some with their maximum velocity, others with their minimum velocity, others, again, with intermediate velocities. We may make addition of all these kinetic energies of the whole solar system, and differentiate the total equation with reference to time. The *variations* thus obtained *for each hour* will naturally eliminate all the *quantities of constant kinetic energy* represented by the rotation of the stars on their own axes; they will merely show the increase or the diminution of the whole of the variable kinetic energies of the system.

One may easily draw a curve of these variations calculated by the ephemerides of the principal planets. Jupiter will play a preponderating *rôle* in this calculation.

Considering still the second hypothesis, in which the attraction is merely the result of shocks, it is evident that the attraction manifested by each planet for the bodies which are on its surface will be the echo of the kinetic energy disposable on this planet. *This kinetic energy will be variable according to the day and hour of observation.*

In fact, the kinetic energy of the solar system *being fixed and constant*, if the planets, on a certain day, absorb into their own mass a maximum quantity of kinetic energy, the *cause of gravity on the earth* will be diminished by the whole of the excess which is accumulated in these bodies in motion, and the *acceleration* g will pass through a *minimum*. On the other hand, when, a few years later, the whole of the planets give a minimum total of kinetic energy for their masses in motion, the value of g, for the same reasons, must pass through a maximum.

It is easily understood that the value of the terrestrial attraction cannot remain constant if the disposable kinetic energy varies in function of the time and of the respective position of the other planets.

Now, we may calculate the total mass M of the system, the partial masses and their variable velocities; we obtain for these variations *considerable values;* then if we register carefully the values of g obtained directly during observations which must continue at the least several years, and if we trace a curve of the values of g so obtained, we should find the following coincidence:—

The curve of variations of the total kinetic energy of the planets must be inverse to the curve of values of g *referred to the same time.*

The differences between the maxima and the minima of the two curves, taken on the same ordinate, will give the measure of the velocity of propagation of the kinetic energy in the ether of the solar system.

These conclusions are rigorous in the case of the hypothesis,

$$\frac{1}{2} mv^2 = \text{constant},$$

being in accordance with nature.

In the case, on the other hand, of attraction being an essential property of matter, and of our having—

$$\frac{1}{2} mv^2 + \text{the potential} = \text{constant},$$

we should find for g a *constant*, since g is the sole manifestation of a constant potential, supposing the mass of the earth is constant during the course of the observations of g.

It will be necessary, then, to take account of perturbations of the moon for the measurements of g, as also of those of the sun, then to verify whether, these corrections having been made, g is constant.

I believe that this experimental method is the only means we possess of diagnosticating with certainty on the essential properties of matter, and of deciding between those two great theories which are both maintained by men of incontestable merit.

As to the measurement of g, there are several operative processes, and it will be indispensable, before commencing observations, to discuss analytically the advantages of each of them, and the modes of inscription of the values obtained.

The optical means of registration, the mechanical actions connected with the motion of pendulums, and the kind of pendulums, will be so many important subjects of discussion, in the case of taking these researches in hand, which I consider as very useful for the definitive settlement of physical theories.

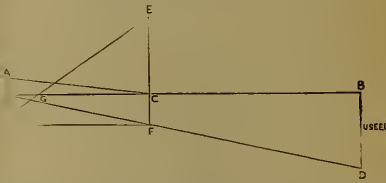
This is a rather long letter, you see, dear Teacher; but I thought to explain to you the object which I pursue, in its general traits, happy indeed if the experiments may be undertaken under your benevolent auspices.

Accept, dear Teacher, I pray you, the expression of my gratitude and entire devotion. RAOUL PICTET

A GEOMETRICAL CONSTRUCTION GIVING THE RELATION BETWEEN THE WASTE AND USEFUL WORK IN A SHUNT DYNAMO

THE ratio between the portion of electrical energy utilisable in the external circuit of a shunt dynamo and the portion wasted in heating the wire of the armature and field magnet is easily calculated as soon as one knows the resistances of the armature and magnet wires, and the resistance equivalent to the external circuit; and I do not know that there is any great advantage in putting it into a geometrical form. Still there are people who prefer a construction to a formula, and the following construction is easily made, especially with the use of squared paper.

In the figure annexed, let O A represent the resistance of the armature between the points where the branching occurs; O B the resistance of the field magnet wire; and O C the resistance of the external circuit, or its equivalent.



Erect lines to represent the useful work (E.M.F. × current), on any convenient scale, at C and at B; viz. C E and B D.

Join O D, producing E C to meet it at F.

Lay off C G equal to E F; draw E G and a horizontal through F.

Then from their meeting point K draw a vertical, meeting C A in H.

The length H K so determined represents the waste portion of the total electrical energy, on the same scale as B D or E C represents the useful.

In this figure the effect of the armature resistance in tilting up the line C A and so increasing the waste is very manifest; the increase of waste by decreasing the resistance O B is somewhat less striking, but quite distinct; the effect of a change in O C is, as it should be, not so obvious. It may be noted that the most economical value for O C is very nearly indeed a geometric mean between O A and O B–O A; which is an easy rule to apply in practice.

Liverpool, July 19 OLIVER J. LODGE

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE following is the list of candidates successful in the competition for the Whitworth scholarships, 1882, in connection with the Science and Art Department:—Charles Webster, apprentice; John H. Tomlinson, apprentice; James M. Beaman, fitter; Thomas Turner, engineer; D. Codrington Selman, engineer; Charles B. Outon, draughtsman; George H. Banister, draughtsman; Frederick Lane, fitter; William D. Laird, engine fitter; Joseph Parry, engine fitter; Albert F. Ravenshear, apprentice; Charles W. Carter, brass-finisher; Alfred Barrow, fitter; Henry C. King, fitter; Malcolm Douglas, apprentice; Thomas H. Gardner, engineer; Ernest E. Haine, engineer; George Halliday, engineer; George W. Buckwell, draughtsman; Louis H. Cochrane, engineer; William Duncanson, engine fitter; Henry Brown, engineer; William T. Hatch, apprentice; Thomas Carlyle, draughtsman; Alfred J. Hill, draughtsman.

A TECHNICAL school is about to be established at Leicester, the main features of which will be to give instruction in the technology of spinning, and the technology of framework knitting. The governors of the Wyggeston Schools have given 1000*l.* towards this object, the Science and Art Department, South Kensington, has promised 500*l.*, 1000*l.* has been raised by subscription, and another 1000*l.* is all that is required to complete the scheme for the present. The movement has been undertaken by the Chamber of Commerce and the Rev. Canon Vaughan. Mr. Henry Mitchell, president of the Bradford Technical School, has received from the Worshipful Company of Clothworkers, London, an intimation to the effect that they have decided to give 300*l.* a year towards the maintenance of the school.

SCIENTIFIC SERIALS

Bulletin de l'Académie Royale des Sciences de Belgique, No. 5.—On the coralline origin of Devonian limestones of Belgium; reply to M. Dupont, by G. Dewalque.—Photography on the railway and in balloons, by R. Candèze.—On surfaces of involution, by E. Weyr.—On the integration of a class of equations with partial derivatives of the second order, by F. G. Teixeira.—Note on a new method for measuring the resistance of batteries, by P. Samuel.

Journal de Physique, June.—Electrical phenomena of hemihedral crystals with inclined faces, by Jacques and Pierre Curie.—Historical researches on the standards of weights and measures of the observatory, and the apparatuses that have served in their construction, by C. Wolf.—Units adopted for absolute measures by the International Congress of Electricians, by H. Pellat.—Thermodynamic analogy of thermoelectric phenomena and the phenomenon of Peltier, by E. Bouty.—Assimilation of the experiments of Hall and Faraday to the effects of the gyroscope, by B. Elie.—Magnetic gyroscope, by A. Crova.

Atti della R. Accademia dei Lincei; Transunti, vol. vi., fasc. 12.—On the pigments of bile, by S. Moreggia.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, July 17.—M. Blanchard in the chair.—The following papers were read:—Report on a memoir by M. Ph. Gilbert on various problems of relative motion, by a Committee. This memoir is a study of the motion of gyroscopic apparatus, viz. (1) Foucault's gyroscope; (2) the torse-pendulum, which the author modifies, getting a more sensitive form, the *barogyroscope*; this may be used instead of Foucault's instrument to prove the earth's rotation; (3) the top. The newest and most original part of the work is that relating to (2).—On a point of the theory of perturbations, by M. Radau.—Astronomical observations without measurement of angles, by M. Rouget. He designates them *circumzenithal*.—On the shock of a plane elastic plate, supposed indefinite in length and in width, by a solid which strikes it perpendicularly at one of its points, and which remains united to it, by M. Boussinesq.—On the variations of gravity, by M. Mascart. The idea of measuring variations of gravity at different points of the globe by the height of the mercury column which balances the pressure of a given mass of gas at constant temperature, M. Mascart has sought to realise, and he finds the method capable of great precision. He uses a kind of siphon-barometer with the short branch closed and holding CO_2, introduced at a pressure sufficient to balance a mercury column of 1 m., when the tube is vertical. The instrument is placed in a metallic cylinder filled with water, which is agitated by an air-current, and contains a thermometer measuring $\frac{1}{100}$ deg. The divided scale is fixed on the tube; one sees it by reflection on a gilt surface, which sends the virtual image into the axis of the tube, and the mercury is seen through the gold layer. Thus one can see, with a single microscope, the mercury-level and the corresponding division of the scale. M. Boussingault recalled having used a similar apparatus during his stay at Ecuador, near the mines of Marmato (1,600 m. alt.) Not finding any variation in the mercury column, he inferred there was no perceptible change in the intensity of gravity during the experiment.—On lightning conductors, by M. Melsens. In support of his system of multiple conductors forming a sort of cage, he cites the experiment in which animals within a metallic cage are unharmed by discharge of a powerful battery of Leyden jars through the cage.—On the hydrate of sulphuretted hydrogen, by M. de Forcrand. A claim of priority.—Researches on the use of crusher-manometers for measurement of pressures developed by explosive substances, by MM. Sarrau and Vieille. They attached to the piston of the crusher a thin piece of leaf-steel to mark a rotating blackened cylinder; and the curve, at explosion, was compared with a sinuous trace made by a tuning-fork at the same time. Results are promised soon.—On the limiting degrees of nitrification of cellulose, by M. Vieille. Cotton wadding was put in 100 to 150 times its weight of nitric acid of various degrees of concentration and at 11°. The last nitrated product obtainable thus is mononitrated cotton (liberating 108 c.c. of bioxide of nitrogen); it is got from nitric acid with 3 eq. of water (density 1·450). By use of sulphonitric mixtures, the author reached, as upper limit, a liberation of 214 c.c. of bioxide of nitrogen, nearly corresponding to the formula $C_{14}H_{29}(NO_4)_{11}O_{10}$.—Influence of compressibility of elements on compressibility of the compounds into which they enter, by M. Troost. The variation of the coefficient of compressibility of vapour of iodine appears again in the vapour of iodide of mercury.—On the derivatives of cupreous sulphites, by M. Etard.—On the gastric juice, by M. Chapoteaut. The aqueous solution of gastric juice (dried and washed previously with ether), treated with alcohol or sulphuric acid, gives a white precipitate, which appears to be the active principle of the juice; its composition is near that of albumen—On the products of distillation of colophany, by M. Renard.—On a new class of cyanised compounds with acid reaction; cyanomalonic ether, by M. Hailer.—On two new antiseptics, glyceroborate of calcium, and glyceroborate of sodium, by M. Le Bon. The latter (and better) has the advantage over carbolic acid of being soluble in water in all proportions, and quite harmless. For disinfection, meat preservation, &c., its fitness is established.—On the industrial conditions of an application of cold to destruction of germs of parasites in meat destined for food, by M. Carrè. With the author's apparatus as applied since 1876 in vessels for importation of meat from La Plata, &c., the cost price is slightly under 0·01 franc per kilogramme. The temperature of − 40° or − 50° applied for an hour or so is fatal to germs; this is reached in the domestic apparatus (with ammonia).—On the visibility of luminous points, by M. Charpentier. With equal brightness and distance this visibility is directly proportional to their surface, or the square of their diameter; with equal brightness and dimensions, inversely as the square of their distance from the eye; with equal dimensions and the same distance, directly as the illuminations.

CONTENTS

THURSDAY, AUGUST 3, 1882

FRANCIS MAITLAND BALFOUR

DEATH has been striking heavy blows at Cambridge. Only a little while ago we were mourning the loss of Maxwell, taken from us, as it seemed, in his prime, when we were fondly hoping that for many years yet to come, the bounds of science would continue to be widened by the labours of his powerful mind; and now Balfour has been snatched from us in the very flush of youth, with his work only just begun, for what he had achieved, great as it was, seemed to his friends only an earnest of that which was yet to come.

The editor of NATURE has asked me to write a few words about my lost friend; and I obey, feeling it my duty not to refuse, painful as the task is.

Francis Maitland Balfour was born in 1851 or 1852 (I cannot at this moment find out which), and was therefore, at the time of his death, only about thirty years of age. After spending some years at Harrow, where he gained the reputation of being a bright, clever boy, but raised no adequate expectations of what he was about to become, he entered at Trinity College, Cambridge, in October, 1870. He had the good fortune to become at once the private pupil of Mr. Marlborough Pryor, who had just been elected the first Natural Science Fellow at Trinity, and though Balfour had already turned towards natural science, and indeed had gone pretty fully into the geology of his native county (Haddingtonshire), I cannot but think that the direction of his studies, and so of his future career, was largely determined by Pryor's admirable influence. I myself was called to Trinity College as Prælector at the same time that Balfour entered, and I believe he, in his second term, attended the lectures which I was then giving; but I did not distinctly make his acquaintance till March, 1871, when I took part in an examination at Trinity College, which resulted in Balfour being elected Natural Science Scholar. From that time onward we became more and more intimate, and I took an increasing share in the direction of his studies.

Discovering very early how great his powers of mind were, and learning that his private resources were such as to enable him to disregard the pecuniary advantages of academic success, I did, what seemed to some at the time, a rash thing: I counselled him to neglect the ordinary routine preparation for his degree, and to apply himself at once to original work. His mind from the first was drawn towards morphology rather than towards physiology; and, as I was then attempting to embody in a small volume some of the lectures on embryology which I had given in London and Cambridge, I proposed to him that he should associate himself with me in the work, and undertake at once the investigation of some of the many embryological problems which lay to hand. He did so, and the results of these, his early labours, are partly contained in the papers "On the Layers of the Blastoderm," "On the Primitive Streak," and "On the Development of the Blood-vessels," published in the *Quarterly Journal of Microscopical Science*, July, 1873, and are partly scattered and hidden in the little work "On the Development of the Chick," which bears his name and mine. The larger achievements of his succeeding years have of course overshadowed these works of his 'prentice hand; but while he was engaged on them, that power of acute observation, rapid grasp of the meaning of things, and strict faithfulness of statement, which all have since recognised in him, became evident to myself at least.

In December, 1873, after breaking off his original work for two or three months in order to prepare himself more definitely for the examination, he obtained his B.A. degree in the so-called Natural Sciences Tripos. Happily and wisely just then the University of Cambridge had secured two "tables" at the newly established zoological station at Naples, and in the early winter, Balfour, in company with Mr. A. G. Dew-Smith, started off to work there. His knowledge and insight had already led him to expect that much might be learnt from the investigation of the early history of the Elasmobranch Fishes, and that accordingly was the problem which he set before himself, and on which he worked during that and succeeding years.

The results of those labours, embodied in his Monograph on the Development of the Elasmobranch Fishes, published as a volume in 1878, but as separate papers in the *Journal of Anatomy and Physiology* from 1876 to 1878, and in the *Philosophical Transactions* for 1876, are known to all biologists. This is not the time to point out in detail their value, but this at least may be said that from the very beginning to the very end of the investigation almost every step serves to throw light on important biological problems. Every chapter from the first, which deals with the ovarian ovum, to the last, which treats of the urogenital organs, contains a record of inquiries which have left their stamp on morphological doctrines. When I remember what embryology was, when in 1871 Balfour learnt his first lessons in it from my imperfect lips, and reflect what it is now, the progress of ten years appears little short of marvellous: and how much of that progress is due to the hand and brain which a slip on the treacherous mountain path has snatched from our midst!

In October, 1874, an election to a Natural Science Fellowship, at Trinity College, took place. Happily the governing body of the College had previously determined to make a new departure, and to allow original work, as well as the results of an examination, to weigh in the decision of the electors. I believe I am betraying no secret in saying that had the election been determined by an examination alone, Balfour would never have been Fellow of Trinity, and Cambridge would probably have lost one of its brightest ornaments. Balfour was one of those able men who never "do themselves justice in an examination-room," and his performance in answering the set questions was inferior to that of his competitor. But the winter at Naples had already borne fruit; and Prof. Huxley, who kindly assisted in the examination, gave such testimony as to the value and promise of so much of the work on the Elasmobranchs as had already been done, that no hesitation as to choosing Balfour was possible.

This success encouraged him to even increase his activity. He continued to work either at Naples or in Cambridge, and in 1875, after delivering a short course on embryology for me, he began (upon the invitation of Prof. Alfred Newton and with the support of Mr. J.

VOL. XXVI.—No. 665

W. Clark) to give definite lectures upon animal morphology, at first in conjunction with Mr., now Prof. Milnes Marshall, but after two terms, by himself. From that time up to last Christmas his labours were enormous, and his energy untiring. His class grew rapidly in numbers; he had to separate the students into an elementary and advanced division, each with separate lectures, and courses of practical instruction; and though he soon gained the able assistance of Mr. Adam Sedgwick and others as demonstrators, all his pupils enjoyed the priceless advantages of close personal contact with himself. At the same time he carried on, either by himself, or through his pupils, a large number of independent investigations into various problems of embryology and morphology, and set himself to write that great work on "Comparative Embryology," every page, and indeed every line of which is marked at once by the widest knowledge and the clearest insight, and which will tell men in long years to come how great is our loss to day. And all the while he was most active in university and college matters; every syndicate almost was desirous to secure his services, and in the framing of the new statutes of Trinity College he took among the junior fellows a prominent part.

During all these exertions his friends, and I not less than any of them, watched him with anxious care. But he was wise as well as zealous, and never went too far; and when, the second volume of the big book being off his hands, he started last Christmas for a holiday to Messina, the prospects of his health seemed to me better than ever. On his journey outward, he found one of his pupils who had gone to study at Naples laid up with typhoid fever at Capri, and with characteristic kindness he halted to nurse the patient till friends could arrive from England. On his return home, he himself was struck down by an attack of the same fever, which at first threatened to be severe, but happily proved otherwise, and speedily left him; and soon after there came an event which was to him one of the greatest pleasures of his short life.

His fame was now spreading rapidly wherever science reaches, and honours were coming thick upon him. In 1878 he was elected Fellow of the Royal Society, and in 1881 was not only placed on the Council, but received the high distinction of a Royal Medal. In the same year the University of Glasgow conferred on him the degree of LL.D., the British Association, at the York meeting, chose him as one of the General Secretaries, in December last a brilliant company assembled at Cambridge to greet him as President of the Cambridge Philosophical Society, and while he was on his sick bed, the Committee of the Athenæum elected him, as a distinguished man of science, a Member of that Club. Moreover, other Universities were eager, if possible, to win him for themselves. I believe it is no secret that many efforts were made to induce him to become the successor at Oxford of the lamented Rolleston; and it is certainly no secret that the Government again and again pressed him to take the chair of Natural History at Edinburgh. He, however, remained faithful to his Alma Mater, and though, owing to difficulties arising out of impending changes, his merit, in spite of the esteem and pride with which all men at Cambridge regarded him, remained without adequate recognition in his own University, he chose to remain with us, waiting till the future should bring him his dues.

Happily a special effort disclosed the fact that the difficulties were, after all, not unsurmountable; and at last, this spring, with the approbation, I believe, of the whole University, scientific or otherwise, and certainly to the great joy of his friends, a special chair of Animal Morphology was created for him, and he was placed in it.

With this recognition of his worth, which he, I believe, valued beyond even his weightier honours, with the prospect of the increased facilities which the new statutes would give in the coming session, and with his health becoming rapidly restored (for since his fever he had nursed himself, doing but little work, or what to him was little), all the future seemed brighter than it had ever seemed as yet. And when in early July I parted with him, and heard him promise that on those perilous Alpine tracks, he, remembering his past illness, would try nothing rash or likely to strain his powers, I looked forward to meeting him again, both of us perhaps fuller of hopes and plans than we had ever been before.

Of the details of his death, at the moment of writing, we as yet know very little, save that some fatal slip on the glacier of Fresney, above Courmayeur, hurried him and his guide to an instantaneous death.

And now comes the hardest part of my task. The world of science knew Francis Balfour as an investigator of the brightest promise, who, indeed, as a mere youth, had already solved morphological problems which had heretofore baffled the acutest minds, and of whom it seemed difficult to say how far he might not reach. A smaller circle in this country and in Europe knew him also as a man whose firm will and rapid but clear judgment were all the more effective, because his decisions and resolves were made known to others with a winning courtesy and with a kindly sensitive regard for the feelings of those from whom he might differ in opinion. But only those who had the privilege to be his friends knew his real worth, for they alone were aware how much the light of his personal character outshone even his scientific achievements and his administrative powers. It will need great knowledge and skill on the part of him who attempts to show exactly how much science owes to Francis Balfour as an inquirer, a teacher, and a counsellor; but that will be an easy task compared with the effort to tell to those who did not know him what he really was. Workers in biology all the world over will feel that a light has gone from the world when they hear the sad news that he is dead, Cambridge men who have watched events at Cambridge during the last ten years will know that a wholly irreparable loss has fallen upon their University, but their grief and their loss is a small thing put by the side of the emptiness which is left for them whose daily life was brightened by the light of his countenance. These mourn for Lycidas, and cannot be comforted.

M. FOSTER

THE MOUNT WHITNEY EXPEDITION

EXPERIMENTS at the Alleghany Observatory in 1879 and 1880, upon the selective absorption of the solar rays by the earth's atmosphere, having made it probable that the amount of heat the sun sends us (the solar constant) had been under-estimated by the methods of previous observers, and that conclusions of importance connected with the temperature of the planet remained to be drawn, it became desirable to verify these results, obtained near the sea-level, by direct simultaneous observations at the base and summit of a very high mountain.

The generosity of a citizen of Pittsburg had provided the special apparatus devised for the new methods, but this was too elaborate to be easily moved to a distant and elevated station. Upon the bearing of the contemplated observations on practical problems of meteorology becoming known to Gen. W. B. Hazen, the Head of the U.S. Signal Service, he kindly offered to facilitate the transportation of an expedition from the Alleghany Observatory to the Western Territories; for no wholly suitable site presented itself, save in regions where the aid of the army might be desirable both for transportation and escort.

With the consent of the trustees of this Observatory, the offer was gladly accepted, and the expedition, which, as originally planned, was a private one, proceeded with material aid from the Signal Service; and under the advantage of Gen. Hazen's official direction I am enabled, by his kind permission, to here briefly indicate its main objects and results, in advance of a full publication of them, which will shortly be made.

The site selected, on the suggestion of Mr. Clarence King, and after conference with officers of the Army and Coast Survey familiar with the western wilderness, as suited to the special observations (which made both great altitude and great dryness desirable), was Mount Whitney in the Sierra Nevada of Southern California. It rises to nearly the height of Mont Blanc from one of the most arid regions in the world, and so abruptly, that two stations can be found within easy signalling distance, whose difference of elevation is over 11,000 feet. It is, however, on the other side of the continent, in an imperfectly explored region, and as very little was known of the possibility of carrying such apparatus as ours to the summit, a military escort was provided, on the contingency of our being obliged to occupy some site still more remote from civilisation.

The scientific members of the party, consisting of Capt. O. E. Michaelis, of the Ordnance, of Messrs. J. E. Keeler and W. C. Day, civilian assistants, and the writer, started from Pittsburg on July 7, for a railroad journey of over 3000 miles, which was greatly facilitated by the courtesy of Mr. F. Thomson, of the Pennsylvania Company, which enabled the writer to take all the apparatus with him in a special car. At San Francisco, after some delay, which the kindness of General M'Dowell, commanding the department of the Pacific, enabled us to pass agreeably, the escort was provided, and the party joined by Mr. George Davidson and two Signal Service non-commissioned officers. With these it proceeded to a point about 400 miles further south (Caliente), where we exchanged the swift motion and the comforts of the Pullman car, for the sharp contrast of a route which commenced (with the shade thermometer registering 110° F.) by a slow journey across the Inyo Desert, shadeless and waterless, for one hundred and twenty miles. We reached, at the close of the month, Lone Pine at the foot of the Sierras, where a camp was made, to be occupied as a lower station, and where the instruments were set up. Among these was a massive siderostat, sending a horizontal beam to a specially constructed spectrometer, an instrument larger than the one which usually bears the name, and in which the eye is replaced by a bolometer, so adjusted as to measure the heat separately in any ray of the visible and the invisible spectrum. When these measures are repeated at an altitude so great that the total atmospheric absorption is markedly different, we are enabled to determine the rate of this absorption for each ray, and, inferentially, to place the observer wholly outside our atmosphere, and to reconstruct the whole spectrum with the hitherto unknown distribution of energy which must exist there. This was used in connection with actinometers, pyrheliometers, and the usual instruments for such a research; but the problem of the safe transportation of the larger apparatus to the summit of Mount Whitney, which now rose above us in a seemingly perpendicular wall of granite, here presented itself in its full difficulty. Our final destination at the summit was in the clearest view, for the extraordinary dryness of the air and the absence of all aërial perspective made the mountain seem so near, that it wore the aspect of a quite neighbouring pile of lofty and moss-covered gray rock, patched with white, and of a wildly jagged outline (the "Sierra"). This white (which we knew to be large snow fields), and the use of the telescope, which resolved the "moss" into great forests, dispelled the illusion, and we realised the obstacles we had to surmount. A preliminary exploration showed that the ascent was difficult, and with such apparatus as ours impossible; a long detour was therefore necessary to avoid the precipices on the eastern front, and our mule trains were in fact occupied from seven to eight days in reaching a point below the summit actually but sixteen miles distant. We traversed in the ascent a trackless wilderness, climbing what seemed utterly impracticable stony heights; down which, once or twice a mule lost his footing and rolled with his scientific freight, but over which, though by such a way as siderostats and telescopes probably never travelled before, all finally passed with a degree of safety beyond our hopes.

We had come here to determine (among other objects) what part of the surface temperature of the planet was due to the sun's direct radiant heat, and what part to the effect of the earth's atmosphere in storing this heat.

It was interesting then, if not wholly agreeable, to repeat the experience of former observers in our own persons, and to notice that as we ascended and the air grew colder, the sun grew hotter, till our faces and hands, browned as they already were by weeks of sunshine below, were burned anew, and far more in the cold than in the desert heat. As we still slowly ascended, and the surface-temperature of the soil fell to the freezing-point, the solar radiation became intenser, and many of the party presented an appearance as of severe burns from an actual fire, while near the summit the temperature in a copper vessel, over which was laid two sheets of plain window glass, rose above the boiling-point, and it was certain that we could boil water by the direct solar rays in such a vessel among the snow-fields.

It is possibly worth remark that owing to the dryness of the air, though isolated snow-fields lay above and below us, the ground we travelled over was bare, and it could not be asserted (as it has been of cases at like altitudes in the Alps), that reflection from the snow had anything to do with the state of our very literally "burned" faces.

In view of the lateness of the season it was decided to make the permanent camp at an altitude of rather less than 13,000 feet, rather than wait and make a road to the peak, which rose 2000 feet above us, and was daily climbed for observations with portable instruments.

The sky was perpetually fine, of a deeper violet than I have observed elsewhere, even on Etna, and the dryness extreme, though water from the snow-fields above was abundant. An equatorial telescope of $5\frac{1}{2}$ inches aperture, which was kindly loaned by Prof. E. C. Pickering, it was found too late could not be well used to determine the quantity of the "seeing," owing to a maladjustment of the eye-pieces, which it was necessary to hold in the hand. Under these circumstances a critical estimate of the definition under high powers could not be made, but enough was seen to make it evident that it was generally excellent, and that such a site possessed advantages for an astronomical, as well as for a meteorological station.

It is greatly to be desired that it should be occupied, with the protection of a permanent building, adapted to either object, and it is probable that such provision will be hereafter made.

For us, however, there was no other shelter than our tents, and the high wind, the cold, and the mountain sickness consequent on the rarefied air, made the continuous observations which were kept up synchronously with that at the camp at Lone Pine, a matter of difficulty. These observations were persistently maintained, however, but we were not sorry on September 11 to break up our wintry camp and to descend to summer again. We resumed our journey across the desert, and then across the continent, reaching Pittsburgh on September 28, 1881.

The reductions of the observations are still incomplete, but some conclusions of interest may already be indicated.

It has been said that the determination of the amount of heat the sun sends the earth is the fundamental problem of meteorology, since on this all the phenomena which that science contemplates depend. Accordingly the observations were directed first to this primary object, chiefly through methods which involved the study of the phenomena of selective absorption (so intimately connected with it), and secondarily to these phenomena considered in themselves.

The final result may be affected by some still imperfectly determined corrections, and it will be sufficient to here give an approximative one.

It appears probable that the true solar constant is one-half greater than that determined by Pouillet and by Herschel near the sea level, and even greater than the recent values assigned by M. Violle. The true value, it is believed, will be shown by the data when published to be larger than those hitherto accepted.

Of more general interest, perhaps, is the conclusion as to the limit of that cold which increases under full sunshine as we ascend above our atmosphere. "What," it may be asked, "would the temperature of the soil be on a mountain top rising wholly above the air, or what the temperature of the sunward hemisphere of the earth, if the present absorbing atmosphere were wholly withdrawn?" The personal experiences already alluded to may prepare the general reader for the paradoxical result that if this atmosphere were withdrawn, the temperature would greatly fall, though under a materially greater radiant heat.

The student of the subject is aware that this conclusion follows from the fact that the loss by radiation into space as the atmosphere is withdrawn is much more rapid than the gain by direct solar heat, but even he may not perhaps be prepared for the extent of the fall.

The original observations, which will be given at length, lead, in the writer's opinion, to the conclusion that in the absence of an atmosphere the earth's temperature of insolation would at any rate fall below $-50°$ F., by which it is meant that (for instance) mercury would remain a solid under the vertical rays of a tropical sun were radiation into space wholly unchecked, or even if the atmosphere existing, it let radiations of all wave-lengths pass out as easily as they come in. Remembering, then, that it is not merely by the absorption of our air, but by the selective quality of this absorption, that the actual surface temperature of our planet is maintained, we see that without this comparatively little-known function, it appears doubtful whether, even though the air supported respiration and combustion as now, life could be maintained upon this planet.

These conclusions do not, in the writer's opinion. depend upon the Mount Whitney observations alone, but exist implicitly in the results of previous observers who have, however, not apparently drawn them, with the exception, perhaps, of Mr. Ericsson, who has observed that the surface of the airless moon must remain cold even in sunshine.

We see, if these results be true, that the temperature of a planet may, and not improbably does, depend far less upon its neighbourhood to, or remoteness from, the sun, than upon the constitution of its gaseous envelope, and indeed it is hardly too much to say that we might approximately indicate already the constitution of an atmosphere which would make Mercury a colder planet than the earth, or Neptune as warm and habitable a one.

It must at the same time be admitted that our information as to the special constituents of our own air, which are chiefly here concerned, is still imperfect, though the observations made at Mount Whitney upon the selective action of that undoubtly prominent agent, water-vapour, will, it is hoped, add somewhat to our knowledge.

In the same connection it may be added that the writer's investigations have led him to the conclusion that the "temperature of space," so called, must at any rate be lower than that assigned by Pouillet (if we accept the received values for that of the absolute zero), and in this case the temperature of the earth's surface, in the absence of the quality of selective absorption in our air, would be yet lower than that here given.

In view of the great importance of this quality, interest will attach to the statement that the bolometer observations at the summit and base of Whitney show a different distribution of solar energy (heat, light, or "actinism") at the upper station from that at the lower, and show (among other things) that without our atmosphere, the sun would appear of a strongly bluish tint, thus confirming observations already made at Alleghany by other methods. It may be added in this connection that researches also there made show a like action in the solar atmosphere, so that we are not only to understand that there is a tendency in both atmospheres to absorb the short waves more than the long ones (as the writer has elsewhere stated), but that the solar photosphere (while emitting radiations of all wave-lengths in greater quantity than we receive them), is, through the immense preponderance of the more refrangible rays before absorption, essentially blue, and that white light is *not* "the sum of all radiations," nor even of all visually recognisable ones, but a composition of the small groups of special rays, which, starting from this essentially blue sun, by virtue of their large co-efficients of transmission, and by a kind of survival of the fittest, have struggled through the solar and terrestrial atmospheres to us, while others of short wave-length have failed on the way. This the Mount Whitney observations, so far as regards the terrestrial atmosphere at any rate, appear to prove.

Doubtless a distinction is to be drawn between the statements of fact and records of direct observation, which will shortly appear in full in the Signal Service publication, and the present inferences from them, for which the writer alone should be held responsible.

In view of the mass of observations on which they rest, and the writer's endeavour to avoid any statement which does not seem to him to express the result of careful and repeated experiments, he hopes, however, that the results to be given in the forthcoming volume will be found to bear out these conclusions, and prove useful contributions from the younger science of solar, to the elder one of terrestrial meteorology. S. P. LANGLEY

Director of the Observatory,
Consulting Specialist U.S. Signal Service
Alleghany Observatory, Alleghany, Pennsylvania,
July 13, 1882

ASIA

Asia. By A. H. Keane. Edited by Sir R. Temple. (London: Edw. Stanford, 1882.)

MR. KEANE'S encyclopædic knowledge in matters of philology and ethnology was never put to better use than in the compilation of this account of Asia. Considerable as is the size of the book, the information it contains is compressed to the utmost; every word is pregnant with meaning, and could not be omitted without injury to the reader. The physical geography, the fauna and flora, the commerce and inhabitants of the vast continent of Asia, are all passed under review; tribes and dialects of which most of us have never even heard the names are discoursed upon familiarly, and facts and statistics bristle in every page. The latest authorities have been everywhere consulted; the geographical results of the late Afghan war, for instance, having been laid under contribution, and full use being made of the Palestine Exploration Survey, not only of Palestine itself but of the eastern side of the Jordan as well. It must not be supposed, however, that Mr. Keane's work is dry reading; his literary ability has thrown an interest over the most matter-of-fact statistics and made us realise the characteristics of the countries he describes or the towns and populations he records.

I need not point out the value to the Englishman of a full and trustworthy compendium like this. As Sir Richard Temple shows in his Preface to the book the interests of England in Asia are enormous, and there is much truth in the German assertion that so far as English power and *prestige* are concerned we are no longer Great Britain but Great India. But it is not only in India that English influence is supreme; our dependencies extend as far as Hongkong, and our trade with Japan amounted in 1880 to over five millions of imports alone. To the student of mankind the interest of Asia is greater than that of any of the other continents of the world. Here was the first home of the races who have chiefly influenced the course of human progress; here the early civilisations of Accad, of China, and of Phœnicia grew up and developed; here the great empires of antiquity rose one upon the other; and here was the primæval source of those germs of thought and art that have produced the philosophies, the sciences, and the arts of our own day. It is among the multitudinous tribes and nations of Asia, too, that we can best study that variety of languages, of manners, and of customs which have enabled the modern inquirer to lift a little the veil that covers the first beginnings of civilisation, and there are even some who believe that the great central plateau of Tibet before it was raised to its present elevation was the primæval cradle of mankind, the spot where the anthropoid ape became the still speechless man. It is possible that our young and therefore arrogant western civilisation has yet much to learn from the old culture of the east, and it is a question whether Sir R. Temple is justified in saying that the Chinese are "implacably hostile to real progress" because they hate "modern (European) progress." At all events the example of Japan is not encouraging.

It is a great pity that Mr. Keane's alphabetical list of the races and languages of Asia had to be sacrificed to the exigencies of space. The room now occupied by a number of very useless woodcuts could well have been given up to it. We must be thankful, however, for the Ethnological and Philological Appendix which he has added at the end. In this he sums up in a clear and trenchant manner the chief facts at present known about the ethnology of Asia. He pertinently points out the great distinction that exists between the different types of race and language we find there. "All races are fertile with one another, though perhaps in different degrees," whereas the stock-languages of the continent "are true species which refuse to amalgamate and thus form new species, so that fresh varieties are developed only within each" of them. The conclusion from this fact seems to me to be that while the different races of mankind may be referred to a single primitive pair, the different families of speech have branched off from independent centres. Mr. Keane, however, still clings to the belief in a single primæval language or type of language, and rejects the hypothesis that man was speechless when the leading races were differentiated from one another. But the argument on which he bases his rejection of the theory is founded on a misconception; language and race are not synonymous terms, and those who hold the doctrine of linguistic polygeneity suppose that different forms of speech grew up independently within the same race or even among the members of a fixed race. It was a question of geography not of race.

The assumption of the primitive unity of speech makes Mr. Keane an adherent of another theory which I have done my best elsewhere to combat. This is that languages develop out of an isolating into an agglutinative stage, and then into an inflectional one. I do not deny that language develops; far from it; the whole science of language is based upon such an assumption. But I can see no facts which warrant me in holding that an isolating language, for example, has ever developed except from one stage of isolation into another. In the same way the inflectional languages have developed only from one form of inflection into another; this is certainly true of the Semitic dialects, and as to the Aryan languages, Dr. Delbrück, the latest defender of Mr. Keane's theory, finds himself forced to admit at the end of a long discussion that a confident "yes" cannot be returned to the question whether the agglutination theory is verified in individual cases. It is only in the sense that the jelly-fish may be called simple that the development of language can be said to be from the simple to the complex; from one point of view, it is true, analysis and differentiation may be termed complex, but most of us would consider our modern English grammar a much simpler affair than that of Gothic or Greek. I may note here, by the way, that Mr. Keane has made a slip in saying that the final *r* of *amatur* is the reflexive pronoun *se*. *R* is also the characteristic of the passive in Old Keltic where it cannot come from an earlier *s*; it is further found in some Vedic verbal forms, and apparently in the Greek *δεῦ-ρ-ο*, where it occupies the same position as in the Latin *ama-r-is*.

Different views, however, as to the conclusions to be drawn from our evidence are inevitable in science, more especially in matters where certainty is unattainable. They in no way diminish the value or importance of Mr. Keane's work, which does not depend on the theories held by himself or any one else regarding the facts put forward in it. He has made "Asia" an indispensable book of reference to the geographer, the traveller, and the statistician; I will not add the politician also, as the main business of the latter nowadays seems to be to avoid acquiring accurate information. Here and there, of course, there is a misprint, as when Prof. Sachau's name is spelt *Sachan* (p. 72), or a statement to which exception may be taken. Thus I am not disposed to endorse the assertion that the Turks in Smyrna "reside chiefly in narrow, dirty slums, into which it is dangerous to penetrate alone, and which are cut off from access to the more open and safer quarters." On the contrary, in walking from the Kassaba station to the quay, when alone and at night, I have always taken good care to go through the Turkish quarter and not through the Greek. Elsewhere, however, Mr. Keane does full justice to the Turks of Anatolia, whom he describes in Dr. Scherzer's words as "honourable in all their dealings, frank, kindhearted, and hospitable, while in religious matters they are, contrary to the general impression, the most tolerant of all Oriental races."

A. H. SAYCE

MAGNETO- AND DYNAMO-ELECTRIC MACHINES

Die Magnet und dynamo-elektrischen Maschinen. Von Dr. H. Schellen. Zweite, nach dem gegenwärtigen auf der Pariser electrischen Ausstellung vertretenen Zustande dargestellte und vermehrte Auflage. (Köln, 1882.)

THIS work, which is considerably enlarged from its first appearance, now includes accounts of all the leading forms of dynamo- and magneto-electric machines with the exception of those of Edison, of which no mention is made. The first chapter is devoted to generalities concerning electromagnets, induction, &c. The second describes magneto-electric machines beginning with that of Pixii and ending with that of De Meritens. The third chapter, on dynamo-electric machines, opens with a rather unseemly revival of the dispute as to priority between Werner Siemens and Wheatstone in the discovery of the action-and-reaction principle of the so-called dynamo-machines. It is a matter of history that papers announcing this discovery were read before the Royal Society on the very same day (February 14, 1867) by Wheatstone and by Dr. C. W. Siemens. We cannot help thinking that Dr. Schellen, in his manner of describing the affair, allows himself to take an attitude extremely unjust towards the great English physicist, now no longer amongst the living; and we protest against this very needless attempt to arouse a scandal. Nor is it true that Wheatstone's memoir contained nothing that Werner Siemens had not previously published in Berlin. The proof of this matter is that Wheatstone's principle of exciting the field-magnets by a derived current in a shunt circuit was adopted as a "new method" by Messrs. Siemens Brothers within two years from the present date, and formed, in 1881, the basis of a communication by Dr. C. W. Siemens to the Royal Society, and of another by Mr. Alexander Siemens to the Society of Telegraph Engineers, in which the priority of Wheatstone in this detail is fully and explicitly admitted. In this chapter also the machines invented by Weston and by Brush are described. Chapter IV. treats of those dynamo-electric machines which generate continuous currents, beginning with Pacinotti's machine of 1863, and including the well-known forms of Gramme and Siemens (v. Hefner-Alteneck), the latter of which is described in very great detail. Hefner-Alteneck's new large dynamo with a disk-armature and many peripheral coils, is mentioned, and the general arrangement of its parts shown. The fifth chapter treats of alternate-current machines. Those of Lontin, Gramme, and Siemens are described fully, but the name of Wilde is not even mentioned! A new machine by Siemens and Halske, capable of giving either intermittent-direct or alternate currents, is figured in this chapter. This section of the book is closed by a disquisition on the theory of dynamos and their efficiency, the greater part being a compilation from the researches of Frölich, Hagenbach, and others.

Chapter VII. deals with the voltaic arc, and Chapter VIII. with electric arc lamps. A mass of details concerning the manufacture of carbon pencils and standards of photometry are included in the former. In the latter chapter most of the chief forms of lamp are given, including those of Crompton, Bürgin, Jaspar, and Serrin. Lamps adapted for use in series or derivation, including the so-called differential lamps, are considered in a separate chapter. Amongst the forms described are those of Gramme, Weston, Brush, Hefner-Alteneck (Siemens), Gülcher, and the Pilsen lamp. According to the author, the differential lamp of von Hefner-Alteneck was the first to make practical the introduction into one circuit of a number of lights. Jablochkoff's well-known candle, and its more recent imitations are described briefly, and then the author passes to the semi-incandescent lamps of the Werdermann type. Edison's incandescent lamp is next described, as it was in the year 1879. All Edison's more recent improvements appear to be unknown to the author, who passes by the Edison exhibit at the Paris Exposition with a compliment upon the good quality of its colour! The incandescent lamps of Lane-Fox and of Maxim are both described and figured, whilst that of Swan—antecedent to both of the latter, as well as to Edison's carbonised filament lamp—is described only, and not figured. Details concerning driving-power, distribution, cost, and fire-risks follow. Applications of dynamo-electric machines to metallurgy, electro-chemistry and telegraphy, make a chapter in themselves, as also does the subject of the electric transmission of power. A penultimate section deals with storage batteries, in which we are glad to observe that full justice is done to Planté, the inventor of the accumulator. A rather sketchy chapter on the mathematical theory of electric arc lighting closes the work.

On the whole, though this work contains useful information on many points, it is much to be regretted that it is not so complete as might have been hoped of a book published in 1882. In a science whose applications are developing so fast, this incompleteness detracts greatly from the value of the work.

OUR BOOK SHELF

The Watchmaker's Handbook. By Claudius Saunier. English Edition, Translated, Revised, and considerably augmented by Julian Tripplin and Edward Rigg, M.A.

THERE is no trade, we suppose, in which so many special tools are used as in watchmaking, nor any in which the character of a workman is so readily distinguished by them. The good workman has good tools—a perfect army of them—nearly all self-made, with which he is prepared to execute any piece of work, in a neat, clean, and efficient manner.

This little book describes watchmakers' tools, but deals with many operations inadmissible from a manufacturer's point of view. "Every watchmaker," says the preface, "will at once recognise that receipts are included which are of the nature of makeshifts, and that it would in many cases be better to replace a piece by a new one, rather than to repair it it in the manner indicated." But there is good reason for this:—"The immense number of badly-constructed watches that he (*the workman*) is called upon to put in going order for a trifling remuneration, compels him to replace the older methods of procedure by others, whenever by so doing time can be saved."

If watches were as big as steam-engines there are few people who would not be horrified at the kind of work put into some of them. But they go well? so they may (or may not), thanks to a strong mainspring, until they are pulled to pieces.

All watch repairers, or "jobbers," as they are technically called, and manufacturers too, ought, however, to be interested in this book. It contains a great deal of useful and instructive information, and it must be left to the consciences of such as to the suggestions herein contained, they would, or would not, adopt.

H. DENT GARDNER

Descriptiones Plantarum Novarum et minus Cognitarum. Fasc. viii. Auctore Dr. Regel. Pp. 150. (St. Petersburg, 1881.)

THE Director of the Imperial Botanic Garden describes a number of novelties cultivated under his own eye. One of the most striking is a new Crinum, (*C. Schmidti*) from Port Natal, which scarcely seems separable by description from *C. latifolium*, L. The bulk of the pages, however, is filled with an enumeration of the glumaceous plants at present known from Central Asia, in the study of which Aitchison's Afghan collections have not been overlooked. 195 species of Gramineæ are enumerated, of which 79 are Asiatic, or at any rate are not known from Europe; 75 species are middle European or Mediterranean; and 37 are common to middle Europe, middle Asia, and North America.

Turning over Dr. Regel's pages affords a ready illustration of the wide diffusion of the components of the British flora. Without pretending to absolute accuracy, we noted that of the 109 species of the British gramineous flora, 65 are recorded by Dr. Regel from Central Asia. We looked with some curiosity to see if any light was thrown on the origin of our cereals. But though rye (*Secale cereale*) appears to occur in a wild state in Turkestan, the forms of wheat met with by botanical collectors were all represented by cultivated specimens. Dr. Regel does not seem to have met with, from Central Asia, *Fingerhuthia Africana*, obtained by Aitchison in his second journey; although only known to botanists from South Africa, it was found to be one of the chief fodder-grasses ol the Lower Kuram Valley.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Spectrum of the Light emitted by the Glow-worm

I AM not aware that any account has been published of the nature of the light emitted by the glow-worm, and therefore venture to send the results of some observations I made on the evenings of the 21st and 22nd of the month.

The light, as is well known, proceeds from the lower surface of the penultimate and ante-penultimate segments of the lower abdomen of the insect, and also from two round spots on the last segment—it is of a greenish colour, and when examined with the spectroscope gives a short continuous spectrum extending from about C to *b*, and therefore containing rays of all wave-lengths between 656 and 518—the more refrangible portion is far the brightest, and the general appearance is of a broad band of green light reaching from about 587 to 518, with a faint continuous spectrum extending down into the red.

I may add that the observations were made with a small direct-vision spectroscope, with a photographic scale; and also that glow-worms are extremely rare in this district.

Reading, July 29

JOHN CONROY

Oscillations of the Sea-level

It seems to be very generally assumed that the surface of the ocean attains a uniform level, or nearly so, in all lands, and forms a sort of zero-point or datum line, from which the altitude of mountains is calculated, and to which barometrical readings are reduced.

This assumption, however, is called in question by several mathematicians, who allege that the sea-level is by no means that of a regular spheroid, as is generally supposed, but may vary many hundreds of feet in level even along the same parallel of latitude, quite independently of the temporary action of winds or of ocean currents.

According to the law of gravitation, all substances attract one another with a force proportional to their masses. A continent of land will therefore exert an attractive influence upon the sea, and cause it to rise upon its shores to a height which will vary according to the mass of land that causes the attraction, and may amount, it is said, to as much as 1000 metres above the level to which the sea attains in mid-ocean. This extraordinary result is deduced by Ph. Fischer from a discussion of pendulum-observations, and somewhat similar conclusions are arrived at by Listing and Heinrich Bruns.

Founding upon these observations, a German geologist, Dr. Penck, has proposed an explanation of the phenomena presented by the raised beaches, and other tokens of oscillation in the sea-level, which are so conspicuous during the glacial period. If the land has the property of thus drawing the sea towards it in proportion to its mass, it follows that anything which adds to that mass will increase the effect, and thus a great thickness of glacier-ice laid upon a continent, will draw the water towards it, and raise the sea-level in its immediate vicinity; and, according as the ice increases or diminishes, so will the level of the sea rise or fall in proportion. Moreover, the altitude of the sea-beach may vary considerably, it is said, along the border of one and the same continent, by reason of the varying thickness of the ice in different parts. In this way it is conceived an explanation is found for the fact that in Norway the old terraces and sea-beaches do not coincide in level, but vary in altitude at places not very far distant from one another. The action of the ice may in short be so localised that its attractive force will vary considerably along the same line of coast.

These views are certainly somewhat different from those that have hitherto prevailed in regard to the regularity of the sea-level. If there is such a very great difference in the height to which the surface of the sea may attain in different places, the barometer should give more indication of it than it seems to do. Nevertheless, it is to be desired that every means should be taken to ascertain the relative height of the sea in various places so chosen as to test the truth of the views I have mentioned. The apparent connection between glaciation and submergence is now attracting notice in various quarters. Dr. Penck maintains that shifts in the relative level of sea and land go hand in hand with oscillations in the glaciation. In 1865 I called attention to this connection, and suggested what seemed to me to be a possible explanation of it (see *Journ.* of the Geol. Soc. vol. xxi. p. 178).

Penck's views, it will be seen, are somewhat different from those of Adhemar and Croll, to which he points out several objections. His memoir is entitled "Schwankungen des Meeresspiegels," and appears in the *Jahrbuch der Geograph. Gesellschaft zu Munchen*, Bd. vii. 1882.

T. F. Jamieson

Ellon, Aberdeenshire, July 31

Voice in Lizards

The above heading in Nature, vol. xxvi. p. 29, rather surprises me, as though voices in lizards were a recent discovery. The loud and plaintive "gui—gui—gui" made by the large land lizard of that name, has been well known to me for the last seventeen years, and is of course well known to every Assamese. The call is always heard in twilight, in the depths of the forest, and when once heard is not mistakable for that of any other animal. It is plain, monotonous, loud, and repeated with two second intervals some eight or ten times, when there is a pause of about two minutes, and it is repeated. For those who do not understand the Hunterian system of spelling I would write it gooee—gooee, the oo most prolonged. The gui is about 3 to 3½ feet long—from snout to tip of tail—which latter exceeds the body and head. Colour grey-green, with clear yellow scales here and there—at times grouped—and that gives a mottled appearance. The tail has a double row of sharp scale-spines along its crest, and if suddenly lashed can cut the skin of any bare-legged bystanders.

It lives in holes under, or in, tree stems, often as high up as 30 or 40 feet. The flesh is eaten and prized, the skin used as the membrane in some kinds of guitars. There seem several kinds, one of 3 or 3½ feet, another larger—both land lizards—a still larger kind frequents the rivers, up to 6 feet or more in length. It hisses like the larger snakes, and the peculiar call that gives it the name "gui," can be heard in still forest I should say a mile; one that repeats this monotonous call every evening is loud enough to be an annoyance at times, though it is over 500 yards off.

S. E. Peal

Sibsagar, Assam

Halo

About 2 p.m. to-day a remarkable halo was visible here. The sky was partially covered with light cirrus clouds, and some small fleecy drift was rapidly moving from the north-west at a low altitude. I saw a bright bow at about 45° from the sun nearly due north, extending over a clear portion of the sky; this gradually extended till it formed a circle with the sun in the most southern point of its circumference. The width of the bow was rather greater than the diameter of the sun, the whole circle being, as near as I could judge, 45° or 50° in diameter. It was brilliantly white, brighter than the white of any clouds in the neighbourhood; it lasted perhaps fifteen minutes, and gradually broke up and faded. I could see no other interesting halo nor any appearance of parhelia.

W. A. Sanford

Tynehead, Somerset, July 25

THE ELECTRIC PROPERTIES OF FLAMES

THE electric properties of flames have often invited the investigation of physicists, but the obscurity and contradictory nature of some of the phenomena have been such that in spite of a large number of researches no complete account of these properties has hitherto been given. Most of these researches are enumerated in a paper contributed by Prof. Holtz to Carl's Repertorium last year; but though Holtz has himself added to our knowledge of the electrical property of flames by his researches on the behaviour of flames when employed as electrodes, he left much yet to be investigated in this department.

The latest contribution to our knowledge of the subject appears in the current volume of Wiedemann's *Annalen der Physik und Chemie*, from the joint pens of Herren Dr. Julius Elster and Hans Geitel. As the results of their investigations go far to clear up some of the points which have hitherto been obscure or contradictory, some account of these investigations will probably not be unacceptable to the readers of Nature.

The chief theories that have been advanced from time to time in explanation of the electrical properties of flames may be reckoned as three in number.

1. Pouillet in 1827 propounded the suggestion that the electricity of flame is due to the process of combustion as such, and therefore presumably analogous to the electrification observed by Volta to result when a burning coal or pastille is placed upon the cap of an electroscope.

2. Matteucci, in 1854, explained the phenomena by supposing that the flame acted upon the two metal electrodes (employed to test its electrification) as an electrolyte; in fact, that it acted as the acid between the two metallic plates of a voltaic cell; a view which practically agrees with that earlier propounded by Hankel.

3. Buff suggested that the explanation was to be sought in a thermo-electric difference between the two electrodes.

Sir William (Mr. Justice) Grove had shown moreover that when a platinum wire is bent so that one end of it stands in the tip of a flame, while the other is immersed in the flame near its base, a current of electricity is set up in the wire. This phenomenon might at first sight be thought to agree with an observation of Hankel, that a flame is "polarised" longitudinally; that is to say, Hankel found there is a difference of potential between the tip and the base of a flame, and this difference of potential is, of course, equivalent to an electromotive force acting along the flame. The want of concord amongst different observers, not only as to the cause of the electrical properties of flame, but even as to what those properties were, is most singular. Probably a great part of it arises from the omission to notice one very important point, namely, the part played in these electrical phenomena by the sheet or mantle of hot air surrounding the flame externally. Almost all these observers have used as their instrument of investigation either a coarse gold-leaf electroscope, or else a galvanometer. The want of sensitiveness and accuracy in the former instrument when applied to small differences of potential, makes the former unsuitable; whilst the high resistance offered by the flame itself to the passage of electricity renders the use of the latter inadvisable.

In beginning their investigation, therefore, Messrs. Elster and Geitel bethought themselves of Sir W. Thomson's quadrant electrometer as admirably suited for delicate and quantitative experiments of the kind in hand, and with this instrument they set themselves to investigate the correctness or otherwise of that which previous observers had announced.

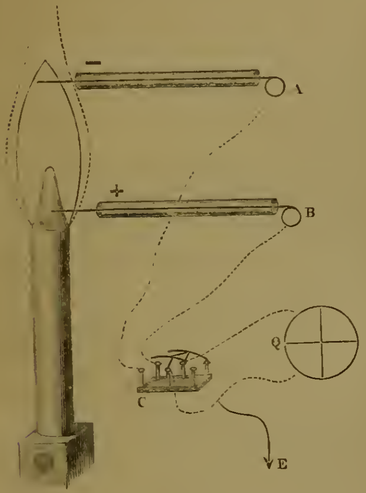


FIG. 1.

Their apparatus was set up as follows:—To keep the needle of the electrometer at a constant charge, it was connected with one pole of a Zamboni's dry pile consisting of 2400 pairs of disks, the other pole being joined to "earth." The electrometer thus arranged was very sensitive, a difference of potential of a single Daniell's cell producing a deflexion of 112 degrees upon the scale of the instrument. One pair of quadrants was as usual put to "earth," and a suitable commutator (C in Fig. 1) was interposed between the electrometer and the flame-apparatus. Experiments were made on the flames of Bunsen burners and of spirit-lamps, both well insulated. A small Bunsen burner specially adapted for this purpose was constructed out of a piece of glass tubing 4 millimetres wide. Fig. 1 shows the manner of exploring the flame. One electrode, A, consisting of a platinum wire inclosed in a glass tube from which the end protruded, was inserted in the tip of the flame. Another electrode, B, of similar kind was fixed so as to pass into the base of the flame. Two points were revealed by the first experiments made:

1. That when set in this fashion the tip was usually electrically negative, as compared with the base of the flame, as Hankel had said, but that sometimes the reverse appeared to be the case.

2. That when the lower electrode was kept fixed, and the upper one was moved to different heights, the potential anywhere within the interior of the flame was the same, being 1·04 times that of one Daniell's cell when the electrodes were 1 millimetre apart, and the same when they were 20 millimetres apart.

If, as Hankel expresses it, a flame were "polarised" longitudinally, cross-sections taken horizontally across the flame should be equipotential surfaces. This is true if the two platinum electrodes A and B are both right within the flame. Whether at the same level or not, when both are completely within the flame they are practically at the same potential—neither of them positive or negative relatively to the other. But if one of the electrodes is displaced to one side, a difference of potential is immediately observed, and this difference is very great if (as in Fig. 1) one electrode passes no further than into the external mantle of hot air.

To examine more particularly the part played by this external mantle was the next point. It will be observed from Fig. 1, that the two electrodes were so chosen that the protruding portion of the platinum wire was equal in length to the width of the flame from side to side. As remarked above, when both were completely immersed side by side in the flame, they showed no electrical difference; but when either of them was moved into the surrounding sheet of hot air, it immediately showed itself positive to the other one. The maximum difference of potential was observed when the electrodes occupied the relative positions shown in Fig. 2, *a*, where the electrode B is about half a millimetre outside the flame. When B was pushed in to the position shown in Fig. 2, *b*, the potential fell to less than half what it was before. When pushed completely in, as in Fig. 2, *c*, the two electrodes were so nearly alike, that the difference of potential between them was less than the hundredth part of that of a single Daniell's cell. The upper electrode, A, was now gradually removed. When it reached the position shown in Fig. 2, *d*, it was decidedly positive relatively to B, and when it was placed as in Fig. 2, *e*, its negative potential was almost as great as its positive potential had been in the first position. The potential of A relatively to B is given in the following table for the five positions:—

a. E.M.F. was −1·29 of 1 Daniell.
b. ,, −0·46 ,,
c. ,, −0·009 ,,
d. ,, +0·65 ,,
e. ,, +1·09 ,,

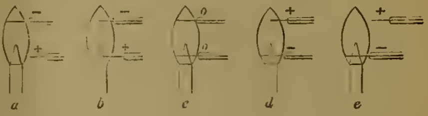


FIG. 2.

To put the matter into words: As long as either of the electrodes is outside the flame and the other inside, the outside one is positive and the inside one negative. The film of hot air outside the flame is always electrically positive, and the flame inside relatively negative.

The same result was obtained by these experimenters with flames of spirit-lamps and with ordinary gas and candle flames. More curious still, when air was made to burn with a flame in an atmosphere of coal-gas the very same phenomena are observed, the hot coal-gas being positive relatively to the air-flame. All these flames showed a potential varying from about 1½ to 1¾ times that of a Daniell's cell. The flame of bisulphide of carbon gave a lower result, and so did a magnesium flame. The introduction of any salt of a metal—such as chloride of potassium—into the flame lowered the potential.

Moreover when wires of other metals were employed the differences of potential were not the same as before. Whilst the lower electrode of platinum remained, the upper electrode was replaced by a copper wire when the potential rose to 2 Daniell's cells. With aluminium it was equal to 3, and with magnesium to 3·2 Daniell's. Using a lump of clean sodium as electrode the potential even rose to five times the Daniell cell.

Using as a fluid electrode a drop of water at the end of a capillary tube similar results were obtained, though the differences of potential were smaller.

These experiments corroborate the suggestion that the flame acts like the acids between the poles of a battery-cell, or that the action is an "electrolytic" one.

Messrs. Elster and Geitel succeeded in joining electrically together the flames of twenty-five spirit-lamps, by the device of causing a curved piece of platinum wire to lead from the base of one flame to the tip of the next, and another piece of wire from the base of this to the tip of the succeeding one, and so on. This "flame-battery" of course had a potential twenty-five times as great as that of one flame. But it would not yield much current, owing to the enormous internal resistance of the flames themselves.

Another most important series of researches was then undertaken to investigate whether, without any *flame* or any products of combustion, a difference of potential could be observed between a red-hot platinum wire and a cold platinum wire whose tip was immersed in the currents of heated air that rose from the former. This was accomplished by using as one electrode a thin platinum wire heated to redness by passing through it the current of a battery. And here, *without any flame*, a difference of potential of about one and a half of a Daniell's cell was found, the upper electrode being positive, relatively to the glowing one. From this experiment, which was confirmed in a variety of ways, it appears that *a flame is not in itself a source of electrification at all.* Messrs. Elster and Geitel therefore regard the electrification as a thermo-electric phenomenon; though they use this term in a slightly different sense from that in which it is used in the text-books.

They conclude, therefore, that the production of electrification by flames is (1) independent of the size of the flame; (2) dependent on the nature and state of surface of the electrodes; (3) dependent on the nature of the gases that are burning in the flame; and (4) dependent on the state of ignition of the electrodes.

They therefore regard Pouillet's theory as being wrong, whilst the theories of Matteucci (and Hankel) and of Buff are both, so far as they go, correct. If this so-called thermo-electric origin of the electrification be the true one it is a very important fact indeed; and, as these able experimenters say, will probably explain the back-electromotive force which is observed in the voltaic arc. This is not the least interesting point in this very interesting research. S. P. T.

THE METEOROLOGY OF ICELAND DURING THE WINTER AND SPRING OF 1881-82

THE observations made last winter by Mr. Thorlacius, observer for the Scottish Meteorological Society at Stykkisholm, Iceland, have been received by the Society, and they are of the greatest interest in connection with the unexampled mild weather which prevailed in this country for the five months ending March. The mean pressures, for these five months, at 32° and sea level, were respectively 29·201, 29·140, 29·295, 29·471, and 29·258 inches, the mean of these months being thus only 29·273 inches. In London the mean of the same months was 30·123 inches, or 0·850 inch higher than that of Stykkisholm. The means for these two places for the twenty-four years ending with 1880 are for London 29·948 inches, and Stykkisholm 29·552 inches, the difference being 0·396 inch, or less than half the difference during the winter of 1881-82. The greatest difference occured in January, the mean pressure for which month in London was 30·365 inches, and at Stykkisholm 29·295 inches. Pressure in the north-west of Iceland was thus 1·070 inch less than in London.

On January 14 the pressure at Greenwich was 30.572 inches, and the maximum temperature 42°·4, but at Stykkisholm on the same day temperature rose to 46°·5, with a storm of wind from the south, and pressure was as low as 28·290 inches, being 2·282 inches lower than at Greenwich. At Greenwich pressure rose at 10 a.m. of the 18th to 30·973 inches, the maximum temperature being 34°·2; but at Stykkisholm pressure on the same day was only 29·466 inches, the maximum temperature rose to 46°·5, and a storm of great violence from the south set in at noon and lasted till 6 a.m. of the following day.

During the five months of high temperature in the British Islands the following winds prevailed less than the average of previous years, viz. W. 4, N. 1, N.E. 6, and E. 8 days; but winds from S.E. were 2, S. 7, and S.W. 14 days above the average. Hence during the winter of 1881-82 atmospheric pressure was not only much under the mean in the north-west of Iceland, but the great depression, which is one of the most prominent features of the meteorology of the northern hemisphere in the winter months, was, as indicated by 21 days' greater prevalence of S. and S.W. winds, situated considerably to the north-west of its usual position. Very low mean pressures for the winter months are of frequent occurrence in Iceland, but it is seldom that they continue uninterruptedly low for five months in succession. Thus, since Mr. Thorlacius began his observations in 1845, mean pressure was nearly as low only on three other winters, viz., the winters of 1847-48, 1850-51, and 1862-63, when the mean pressures of these five months were respectively 29·308, 29·330, and 29·310 inches.

The weather underwent a complete change about the middle of March, when S. and S.W. winds nearly ceased and a high mean atmospheric pressure ruled, with repeated cyclonic disturbances passing to the southward of Stykkisholm, and involving Iceland in a succession of violent north-easterly storms of wind, which broke up the Arctic ice to the north, drove it southward, and stranded it on the north and east shores of the island. In these circumstances the weather became unusually inclement and unseasonable, and Mr. Thorlacius reports that no equally severe and disastrous spring has occurred there within the memory of any one living. About Easter all the food for horses, sheep, and cattle had been used up, and these animals died in great numbers. In his parish alone, 62 horses, 1700 sheep and swine, and 7 cows perished, causing a direct loss of 1220*l.*, and the population has been brought face to face with a serious famine.

Though the Government is taking every measure in its power to mitigate the calamity, the prospect is most gloomy. Besides this, all, or nearly all, of the lambs have died, and owing to the great cold and want of rain, grass has scarcely yet begun to grow, the sea-ice still (July 1) surrounds the entire north and east of the island in immense masses, and no ship can get through it to any of the harbours of these coasts. On the north coast the ice drove ashore about fifty large whales, of which the smallest is said to be forty-five feet in length, which proved an unexpected relief to the poor peasantry, and even to the proprietors of the coast districts.

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA[1]

II.—*Further Examples of the General Law*

FLOWERS in which the carpels have arranged themselves in a circle around a common axis, like the *Geraniaceæ* and *Malvaceæ*, thereby show themselves to be more highly modified than flowers in which all the carpels are quite separate and scattered, like the simpler *Rosaceæ* and *Ranunculaceæ*. Still more do families such as the *Caryophyllaceæ*, in which all the five primitive carpels have completely coalesced into a single one-celled ovary. Accordingly, it is not remarkable that the pinks should never be yellow. On the other hand, this family has no very specialised members, like larkspur and monkshood, and therefore, it very rarely produces bluish or purplish flowers. Pinks, in fact, do not display so wide a range in either direction as *Ranunculaceæ*. They begin as high up as white, and hardly get any higher than red or carnation. Of their two sub-families, the *Alsineæ* have the sepals free, the blossoms widely expanded, and no special adaptations for insect fertilisation. They include all the small undeveloped field species, such as the chickweeds (*Stellaria media, Arenaria trinervis, Cerastium vulgatum*, &c.), stitchworts (*Stellaria holostea*, &c.), and cornspurries (*Spergula arvensis*), which have open flowers of a very primitive character; and almost all of them are white (Fig. 12). These are fertilised by miscellaneous small flies. The *Sileneæ*, on the other hand, including the campions and true pinks, have a tubular calyx, formed by the coalescence of the five sepals; and the expanded petals are raised on long claws, which makes their honey, inclosed in the tube, accessible only to the higher insects. Most of them also display special adaptations for a better class of insect fertilisation in the way of fringes or crowns on the petals. These more profoundly modified kinds are generally pink or red. For example, in the most advanced British genus, *Dianthus*, which has usually vandyked edges to the petals, our four English species are all brightly coloured; *D. armeria*, the Deptford pink, being red with dark spots, *D. prolifer* purplish red, *D. deltoides*, the maiden pink, rosy spotted with white, and *D. cæsius*, the Cheddar pink, bright rose-coloured (Fig. 13).

It is much the same with the allied genus *Lychnis*. Our own beautiful purple English corn-cockle (*L. githago*), is a highly developed campion, so specialised that only butterflies can reach its honey with their long tongues, as the nectaries are situated at the bottom of the tube. Two other species of campion, however, show us interestingly the way in which variations of colour may occur in a retrograde direction even among highly evolved forms. One of them, the day lychnis (*L. diurna*), has red, scentless flowers, opening in the morning, and it is chiefly fertilised by diurnal butterflies. But its descendant, the night lychnis (*L. vespertina*), has taken to fertilisation by means of moths; and as moths can only see white flowers it has become white, and has acquired a faint perfume as an extra attraction (Fig. 14). Still, the change has not yet become fully organised in the species, for one may often find a night lychnis at the present time which is only pale pink, instead of being pure white.

The *Cruciferæ* are a family which display a good deal of variety in colouration. The most primitive and simple forms have yellow flowers, as in the case of the cabbage genus (*Brassica*) including charlock, mustard, and turnip; the rockets (*Barbarea* and *Sisymbrium*); and the gold-of-pleasure (*Camelina sativa*). Most of these are dry-field weeds, and they have open little-developed blossoms. In the genus *Nasturtium* or watercress we have four species, three of which are yellow, while one is white. In treacle-mustard (*Erysimum*), the yellow is very pale, and the petals often become almost white. Just above these earliest forms come the common small white crucifers like *Cardamine hirsuta, Cochlearia officinalis*, and *Capsella bursa-pastoris*. Many of these are little if at all superior in organisation to the yellow species, and some of them (as we shall see hereafter) are evidently degenerate weeds of cultivation. But such flowers as *Alyssum maritimum*, with its sweet scent, its abundant honey, its reduced number of seeds, and its conspicuous, spreading milk-white petals, are certainly more developed than small yellow species like *Alyssum calycinum*. Even more remarkably is this the case in the genus *Iberis* or candytuft, which has become slightly irregular, by the two adjoining exterior petals growing larger than the interior ones. Accordingly, they are usually white, like our British species, *I. amara;* while some of the larger exotic species are a pretty pink in hue. The genus *Cardamine* supplies us with like instances. Here the smaller species have white flowers, and so has the large *C. amara*. But in *C. pratensis*, the cuckoo-flower, they are usually tinged with a pinkish purple, which often fades deep mauve; and in some showy exotic species the flowers are a rich pink. So with *Arabis:* our small English kinds are white; *A. petræa*, with larger petals, is often slightly purplish, and some handsome exotics are a vivid purple. In *Hesperis* we get a further degree of modification in that the petals are raised on rather long claws; and the flowers (represented in England by *H. matronalis*, the dame's-violet) are a fine purple, and possess a powerful perfume. Closely allied is the Virginia stock of our gardens (*Malcolmia*), which varies from pale pink to mauve. But the highest of all our crucifers are contained in the genera *Matthiola* and *Cheiranthus*, which have large spreading petals on long erect claws, besides often being sweet scented. The common stock (*M. incana*) is purple, reddish, or even violet; our other British species, *M. sinuata*, is pale lilac; and no member of the genus is ever yellow. The wall-flower (*Cheiranthus cheiri*) is rich orange or red, sometimes yellow: its colour, however, differs widely from the primitive yellow of the charlocks or buttercups; and it will receive further attention hereafter.

So much by way of illustration of the families with usually regular polypetalous flowers and free superior ovaries. We may next pass on to the families of polypetalous flowers with usually irregular corollas, which represent of course a higher stage of development in adaptation to insect visits. Of these, two good illustrative cases are included in the British flora. They are the *Polygalaceæ* and the *Violaceæ*.

Polygala vulgaris, or milkwort, our only British representative of the first named family, is an extremely irregular flower, very minutely and remarkably modified for special insect fertilisation. It is usually a bright blue in colour, but it often reverts to pink, and not infrequently even to white.

The *Violaceæ* or violets are a whole family of bilateral flowers, highly adapted to fertilisation by insects; and as a rule they are a deep blue in colour. This is the case with four of our British species, *Viola odorata, V. canina, V. hirta*, and *V. palustris*. Here too, however, white varieties easily arise by reversion; while one member of the group, the common pansy, *V. tricolor*, is perhaps the most variable flower in all nature. This case, again, will receive further attention when we come to consider the subject of variegation and of reversion or retrogression.

When we pass on to the *Corollifloræ*, in which the originally separate petals have coalesced into a single united tube, we meet with much more striking results. Here, where the very shape at once betokens high modification, yellow is a comparatively rare colour (especially as a ground-tone, though it often comes out in spots or patches), while purple and blue, so rare elsewhere, become almost the rule.

The family of *Campanulaceæ* forms an excellent ex-

---

[1] Continued from p. 304.

ample. Its flowers are usually blue or white, and the greater number of them, like the harebell (*Campanula rotundifolia*) and the Canterbury bell (*C. media*), are deep blue (Fig. 15). We have nine British species of the genus, varying from pale sky-blue to ultramarine and purplish cobalt, with an occasional relapse to white. Rampion and sheep's bit, also blue, are clustered heads of similar blossoms. The little blue lobelia of our borders, which is bilateral as well as tubular, belongs to a closely-related tribe. One of our British species, *Lobelia Dortmanna*, is sky-blue; the other, *L. urens*, is a dingy purple. Not far from them are the *Dipsaceæ*, including the lilac scabious, the blue devil's bit, and the mauve teasel. Amongst all these very highly-evolved groups blue distinctly forms the prevalent colour.

Fig. 12.—Lesser Stitchwort, white: type of simple open Alsineæ.

In the great family of the *Ericaceæ*, or heaths, which is highly adapted to insect fertilisation, more particularly by bees, purple and rose are the prevailing tints, so much so that, as we all have noticed a hundred times over, they often colour whole tracts of hillside together. The bell-shaped blossoms mark at once the position of the heaths with reference to insects; and the order, according to Mr. Bentham, supplies us with more ornamental plants than any other in the whole world. Among our British species, in the less developed forms, like *Vaccinium*, *Arbutus*, and *Andromeda*, the flowers are usually white, flesh-coloured, pinkish, or reddish. The highly developed *Ericæ*, on the other hand, are mostly purple or deep red. *E. vulgaris* has the calyx as well as the corolla coloured with a mauve variety of pink. *Menziesia cærulea* is a deep purplish blue. *Monotropa* alone, a very degraded leafless saprophyte form, has greenish yellow or pale brown free petals.

Fig. 13.—Dianthus, red spotted with darker tints: type of Sileneæ with tubular calyx.

The *Boraginaceæ* are another very advanced family of *Corollifloræ*, and they are blue almost without exception. They have usually highly-modified flowers, with a tube below and spreading lobes above; in addition to which most of the species possess remarkable and strongly-developed appendages to the corolla, in the way of teeth, crowns, hairs, scales, parapets or valves. Of the common British species alone, the forget-me-nots (*Myosotis*) are clear sky-blue with a yellow eye; the viper's bugloss (*Echium vulgare*) is at first reddish-purple, and afterwards a deep blue; the lungwort (*Pulmonaria officinalis*) is also dark blue; and so are the two alkanets (*Anchusa*), the true bugloss (*Lycopsis*), the madwort (*Asperugo*), and the familiar borage (*Borago officinalis*); though all of them by reversion occasionally produce purple or white flowers. Hounds-tongue (*Cynoglossum officinale*) is purple-red, and most of the other species vary between purple and blue; indeed, throughout the family most flowers are red at first and blue as they mature. Of these, borage at least is

Fig. 14.—Night Lychnis, white: adapted to fertilisation by moths.

Fig. 15.—Harebell, deep blue: type of Corollifloral blossoms.

habitually fertilised by bees, and the same is partially true of many of the other species. All of them are adapted to a high class of insect visitors.

Other families of regular *Corolliflorœ* must be glanced at more briefly. Among the *Gentianaceœ*, the less advanced types, like the simple *Chlora perfoliata* and *Limnanthemum nymphœoides*, are yellow, perhaps by reversion; but *Menyanthes trifoliata*, a slightly more developed ally of *Limnanthemum*, has white blossoms, tinged outside with red; *Erythrœa centaurium*, with a divided calyx and the cells of the ovary imperfectly united, is pink; and the true gentians, *Gentiana verna*, *G. campestris*, *G. nivalis*, &c., with a tubular calyx, long throat, and sometimes fringed hairs to the tube, are bright blue. In *Apocynaceœ*, we have the highly developed periwinkles, *Vinca major* and *V. minor*, normally blue, though pink and white varieties or species are also cultivated. In *Plumbagineœ* we have the bluish purple sea-lavender (*Statice Limonium*) and the pink thrift (*Armeria vulgaris*). Other families with special peculiarities will receive notice later on.

FIG. 16.—Section of Daisy; inner florets yellow; ray florets white, tipped with pink.

FIG. 17.—Flower of Sage, bright blue, visited by bee.

FIG. 18.—*Gagea lutea*, yellow: simplest type of lily.

It is necessary, however, here briefly to refer to the great family of *Compositœ*, some of whose peculiarities can only properly be considered when we come to inquire into the phenomena of relapse and retrogression. Nevertheless, even at the present stage they afford some excellent evidence. In certain ways they may be regarded as the very highest race of flowering plants. Not only are their petals united into a tubular corolla, but their blossoms are compounded into large groups of a very attractive sort. Each flower-head consists of a number of small florets, crowded so as to resemble a single blossom. So far as our present purpose is concerned, they fall naturally into three groups—Jussieu's old-fashioned sub-orders of *Ligulatœ*, *Cynaroideœ*, and *Corymbiferœ*, which are quite sufficient for all ordinary objects of botanical study.

FIG. 19.—Fritillary, purple, spotted with white and red; developed type of lily.

We can only examine the last-named tribe at present, whose central florets, as a rule, are bright golden; a fact which shows pretty certainly that they are descended from a common ancestor who was also yellow. Moreover, these yellow florets are bell shaped. But the outer florets are generally sterile; and instead of being bell-shaped, they form a long ray; while their corolla is at the same time much larger than that of the central blossoms. In short, they are sterilised members of the compound flower-head, specially set apart for the work of display; and thus they stand to the entire flower-head in the same relation as petals do to the simple original flower. Just as the petal is a specialised and sterilised stamen told off to do duty as an allurer of insects for the benefit of the whole flower, so the ray-floret is a specialised and sterilised blossom told off to do the self-same duty for the benefit of the composite flower-head.

FIG. 20.—Spotted Orchid, purple with white patches: type of highly developed bilateral monocotyledons.

Now, the earliest ray-florets would naturally be bright yellow, like the tubular blossoms of the central disk from which they sprang. And to this day the ray-florets of the simplest corymbiferous types, such as the corn-marigold (*Chrysanthemum segetum*), the sun-flower (*Helianthus annuus*), and the ragwort (*Senecio jacobæa*), are yellow, like the central flowers. In the camomile, however, the ox-eye daisy, and the may-weed (*Anthemis cotula*, *Chrysanthemum leucanthemum*, &c.), the rays have become white; and this, I think, fairly establishes the fact that white is a higher development of colour than yellow; for the change must surely have been made in order to attract special insects. In the true daisy, again (*Bellis perennis*), the white rays become tipped with pink, which sometimes rises almost to rose-colour (Fig. 16); and this stage is exactly analogous to that of apple-blossom, which similarly halts on the way from white petals to red. In our own asters (*A. tripolium*, &c.) and the Michaelmas daisies of America, we get a further advance to purple, lilac, and mauve, while both in these and in the chrysanthemums, true shades of blue not infrequently appear. The *Cinerarias* of our gardeners are similar forms of highly-developed groundsels from the Mediterranean and the Canary Islands.

Tubular flowers with an irregular corolla are obviously higher in their mode of adaptation to insect visits than tubular flowers of the ordinary symmetrical type. Amongst them, the first place must be assigned to the *Labiates*. Not only are they deeply tubular, but they are very bilateral and irregular indeed, displaying more modification of form than almost any other flowers except the orchids. They mostly secrete abundant honey, and often possess highly aromatic perfumes. Almost all of them are purple or blue. Among the best known English species are thyme, mint, marjoram, sage (Fig. 17), and basil, which it need hardly be said are great favourites with bees. Ground-ivy (*Nepeta glechoma*) is bright blue; catmint (*Nepeta cataria*), pale blue; *Prunella*, violet-purple; and common bugle (*Ajuga reptans*), blue or flesh colour. Many of the others are purple or purplish. It must be added that in this family the flowers are very liable to vary within the limit of the same species; and red, white, or purple specimens are not uncommon in many of the normally blue kinds.

The *Scrophularineæ*, and other allied irregular tubular families are mostly spotted, and so belong to a later stage of our inquiry; but even amongst this group, the *Veronica* genus has almost always pure blue flowers; foxglove (*Digitalis purpurea*) is purple; and many of the Broomrapes (*Orobanchaceæ*) are more or less bluish. Blue and lilac also appear abundantly in spots or stripes in many species of *Linaria*, in *Euphrasia*, and in other genera.

We have given so much consideration to the Dicotyledons that the relatively simple and homogeneous Monocotyledons need not detain us long. Their coloration is as a whole both less complicated and less instructive.

The *Alismaceæ* answer very closely to the *Ranunculaceæ*, as being in all probability the earliest surviving type of entomophilous Monocotyledons. Their arrangement is of course trinary, but they have similarly separate carpels, often numerous, surrounded by one, two, three, or many rows of stamens, and then by one row of three petals and one row of three sepals. All our English species, however, are white or rosy, instead of yellow. As they are marsh plants, they seem to have reached or passed the stage of *Ranunculus aquatilis*. One species, *Alisma plantago*, the water-plantain, however, still retains a yellow claw to the petals, though the limb is white or pale pink. So also does *Damasonium stellatum*. These two interesting plants present a remarkable analogy to the water-crowfoot.

Among monocotyledonous families with a united ovary, the *Liliaceæ* are probably the most primitive. Their simplest type in England is *Gagea lutea* (Fig. 18), a yellow lily looking extremely like a bunch of *Ranunculus Ficaria*. In *Lloydia serotina*, a closely allied but more developed form, the petals are white, with a yellow base, and three reddish lines. The wild tulip is likewise yellow. *Allium ursinum*, a somewhat higher type, is pure white. The fritillary (*Fritillaria Meleagris*, Fig. 19), a large, handsome, bell-shaped flower, with separate petals converging into a campanulate form, and with a nectariferous cavity at their base, is purple or red, checquered with lurid marks; but it often reverts to white, or even to a faint yellow. In *Scilla*, however, including our common wild hyacinth (*S. nutans*), the deep tubular flowers, composed of perianth pieces with long claws, are usually blue, rarely pink or white; while in *Hyacinthus* and *Muscari*, which have a united bell-shaped or globular blossom, formed by the coalescence of the sepals and petals, dark-blue and ultramarine are the prevalent tones. Meadow saffron (*Colchicum autumnale*), which has also a united tube and very deep underground ovary, is a fine reddish purple: its stamens secrete honey.

The *Irideæ* and *Amaryllideæ* are more advanced than the lilies, in that they possess inferior ovaries—in other words, their perianth tube has coalesced with the walls of the inclosed carpels. In many cases, especially in the more highly-developed species, their flowers are red, blue, or purple. *Trichonema Bulbocodium* is purplish-blue, with a yellow centre. Our two native crocuses (*C. vernus* and *C. nudiflorus*) are also purple. *Sisyrinchium Bermudianum* is a delicate blue. *Gladiolus communis* is brilliant crimson. *Iris fœtidissima* is violet. Our own Amaryllids are white or primrose, but brilliant reds and purples, as well as highly-developed spotted types, are common amongst the cultivated exotics.

The *Orchidaceæ* stand at the head of the entomophilous Monocotyledons by virtue of their inferior ovary, their irregular flowers, and their extraordinary adaptations to insect fertilisation. Purples are the prevailing ground-tones (Fig. 20); but in the commonness of variegation and of specialised lines or spots of colour, the Orchids answer closely to the *Scrophularineæ* among Dicotyledons, and may therefore best be considered in a succeeding section.

GRANT ALLEN

(*To be continued.*)

ASTRONOMICAL OBSERVATORIES [1]

AMONG the contributions of public and private munificence to the advance of knowledge, none are more worthy of praise than those which have been devoted to astronomy. Among all the sciences, this is the one which is most completely dependent upon such contributions, because it has the least immediate application to the welfare of the individual. Happily, it is also the science of which the results are best adapted to strike the mind, and it has thus kept a position in public estimation which it could hardly have gained if it had depended for success solely upon its application to the practical problems of life. That the means which have been devoted to its prosecution have not always been expended in a manner which we now see would have been the best, is to be expected from the very nature of the case. Indeed, a large portion of the labour spent in any kind of scientific research is, in a certain sense, wasted, because the very knowledge which shows us how we might have done better has been gained through a long series of fruitless trials. But it is due both to ourselves and the patrons of astronomy that as soon as any knowledge bearing upon the question of the past application of money to the advance of science is obtained, use should be made of it to point out the mistakes of the past and the lessons for the future. It is now patent to all who have made a wide study of the subject that large amounts have been either wasted or applied in ways not the most effective in the erection and

---

[1] From the *North American Review*.

outfit of astronomical observatories. Since Tycho Brahé built his great establishment at Uraniburg, astronomical research has been associated in the public mind with lofty observatories and great telescopes. Whenever a monarch has desired to associate his name with science, he has designed an observatory proportional to the magnitude of his ambition, fitted it out with instruments on a corresponding scale, and then rested in serene satisfaction. If we measure greatness by cubic yards, then Peter the Great and "Le Grand Monarque" were the founders of two of the greatest observatories ever built. That of St. Petersburg was completed in 1725, the year of Peter's death, and was an edifice of two hundred and twenty-five feet front, with central towers one hundred and forty feet high. It had three tiers of galleries on the outside for observation, and was supplied with nearly every instrument known to the astronomers of the time, without reference to the practicability of finding observers to use them. It was nearly destroyed by fire in 1747, but was partially rebuilt, and now forms part of the building occupied by the Imperial Academy of Sciences. The Paris Observatory, built half a century earlier, still stands, its massive walls and arched ceilings reminding one rather of a fortress than of an astronomical institution.

Notwithstanding the magnificence of these structures, they have had little essential connection with the progress of astronomy. It is true that the work done at both establishments takes a prominent place in the history of science, but most of it could have been done equally well under wooden sheds erected for the protection of the instruments from the weather. In recent times, the St. Petersburg Observatory has been found so unsuitable for its purpose that no observation of real value can be made, and its existence has been nearly forgotten. The great building at Paris, though associated with a series of astronomical researches second to none in the world, has really served scarcely any other purpose than those of a physical laboratory, store-house, and offices. The more important observations have always been made in the surrounding garden, or in inexpensive wings or other structures erected for the purpose.

With these establishments it will be instructive to compare the Greenwich Observatory. The latter has never won the title of great. It was originally established on the most modest scale, for the special purpose of making such observations as would conduce to the determination of the longitude at sea. Although it has now entered upon its third century, no attempt has ever been made to reconstruct it on a grand scale. Whenever any part of it was found insufficient for its purpose, new rooms were built for the special object in view, and thus it has been growing from the beginning by a process as natural and simple as that of the growth of a tree. Even now, the money value of its structure is less than that of several other public observatories, although it eclipses them all in the results of its work. Haeckel lays it down as a general law of research that the amount of original investigation actually prosecuted by a scientific institution is inversely proportional to its magnitude. Although this may be regarded as a humorous exaggeration, it teaches what the history of science shows to be a valuable lesson.

A glance at the number and work of the astronomical observatories of the present time will show how great a waste of means has been suffered in their erection and management. The last volume of the *American Ephemeris* contains a list of nearly 150 observatories, supposed to be, or to have recently been, in a state of "astronomical activity." The number omitted because they have lain inactive it is impossible to estimate; but it is not unlikely that, in this country at least, they are as numerous as those retained. It is safe to say that nearly everything of considerable value which has been done by all these establishments could have been better done by two or three well-organised observatories in each of the principal civilised countries. Indeed, if we leave out of account local benefits, such as the distribution of time, the instruction of students, and the entertainment of the public, it will be found that nearly all the astronomical researches of really permanent value have been made at a very small number of these institutions. The most useful branch of astronomy has hitherto been that which, treating of the positions and motions of the heavenly bodies, is practically applied to the determination of geographical positions on land and at sea. The Greenwich Observatory has, during the past century, been so far the largest contributor in this direction as to give rise to the remark that, if this branch of astronomy were entirely lost, it could be reconstructed from the Greenwich observations alone. During the past twenty years the four observatories at Greenwich, Pulkowa, Paris, and Washington have been so far the largest contributors to what we may call geometrical astronomy that, in this particular direction, the work of the hundred others, in the northern hemisphere at least, can be regarded only as subsidiary.

This remark, it will be understood, applies only to that special branch of astronomy which treats of the positions and motions of the heavenly bodies. The other great branch of the science treats of the aspect and physical constitution of these bodies. It dates from the invention of the telescope, because, without this instrument and its accessories, no detailed study of the heavenly bodies is possible. The field open to the telescope has, during the last twenty years, been immensely widened by the introduction of the spectroscope, the ultimate results of which it is scarcely possible to appreciate. Photography has recently been introduced as an accessory to both instruments; but this is not so much an independent instrument of research as a means of recording the results of the spectroscope and telescope. To this branch of the science a great number of observatories, public and private, have duly contributed, but, as we shall presently see, the ratio of results to means is far less than it would have been had their work all been done on a well-organised system.

Nearly all great public observatories have hitherto been constructed for the purpose of pursuing the first branch of the science—that which concerns itself, so to speak, with the geometry of the heavens. This was naturally the practice before the spectroscope opened up so new and rich a field. Even now there is one sound reason for adhering to this practice,—namely, that physical investigations, however made, must be the work of individuals rather than of establishments. There is no need of a great and expensive institution for the prosecution of spectroscopic observations. The man of genius with imperfect instruments will outdo the man of routine in the greatest building, with the most perfect appliances that wealth can supply. The combination of qualities which insures success in such endeavours is so rare that it is never safe to count upon securing it. Hence, even now, a great observatory for the prosecution of physical research whould be a somewhat hazardous experiment, unless the work it was to do were well mapped out beforehand.

Considering the great mass of observatories devoted to geometrical astronomy, the first thing to strike the professional student of their work is their want of means for a really useful and long-continued activity; and this notwithstanding that their instrumental equipment may be all that could be required. The reason is that their founders have not sufficiently taken into account the fact that the support of astronomers and the publication of observations is necessary to the usefulness of such an establishment, and requires a much larger endowment than the mere outfit of the building. Let us take, for instance, that omnipresent and most useful instrument, the meridian circle. Four or five of these instruments, of moderate size, located in good climates, properly manned, under skilful superintendence, working in co-operation with each other, would do everything necessary for the department of research to which they are applicable, and a great deal more than is to be expected from all the meridian circles of the world, under the conditions in which they are actually placed. They could, within the first five years, make several independent determinations of the fundamental data of astronomy, including the positions and motions of several hundred of the brighter fixed stars. In five years more they could extend their activity so as to fix the position of every star in the heavens visible to the naked eye; and, during the ten years following, could prepare such a catalogue of telescopic stars as there is no prospect of our seeing during the next half-century.

There are probably not less than twenty meridian circles in this country alone, most of them antiquated, it is true, yet, so far as average size and cost are concerned, amply sufficient for the work in question. How many there may be in other countries it is impossible to estimate, but probably fifty or upward, and the number is everywhere constantly increasing. Should we seek out what they are doing, we should probably find half of them rusting in idleness upon their pivots. With others some industrious professor or student would be found making, unaided, a series of observations to be left among the records of the establishment, or immured in the pages of the *Astronomische Nachrichten*, with small chance in either case of ever being used. We may be sure that the solitary observer will soon find something else to do, and leave the instrument once more in idleness. Others we should find employed in the occasional instruction of students, a costly instrument being used where a rough and cheap one, which the student could take to pieces and investigate at pleasure, would answer a far better purpose. Yet others we should find used in distributing time to the neighbouring cities or states, or regulating chronometers for the shipping of a port. I dare not guess how many we should find engaged in work really requiring an instrument of the finest class, and gaining results which are to contribute to the astronomy of the future, but in our own country there would hardly be more than three.

The general cause of this state of things lies upon the surface. It is as true in astronomy as in any other department of human affairs that the best results can be attained only by a careful adaptation of means to ends. Failures have arisen, not from the intervention of any active opposing agency, but because observatories have been founded without a clear conception of the object to be attained, and therefore without the best adaptation of means to ends. To build an observatory before knowing what it is going to do is much like designing a machine-shop and putting in a large collection of improved tools and machinery before concluding what the shop is to make, and what are the conditions of the market open to its products. Some hints on the considerations which should come into play in the erection of any new observatory may not be out of place, as pointing out the remedy for the evils we have described.

Heretofore the practice has usually been first to decide upon the observatory, and to plan the building; next to provide instruments; and lastly, to select an astronomer, and with his advice, to decide what direction the activities of the establishment should take. This order of proceeding should be reversed. The first thing to be done is to decide what the observatory shall be built to do. The future astronomer would, of course, have a controlling voice in this decision, and should, therefore, be selected in advance. One thing which it is especially important to decide is to which of the two great divisions of astronomical research attention shall principally be directed. If the prosecution of geometrical astronomy is kept in view, the conditions of advance in that department of the science must be kept in mind. The public is too apt to associate astronomy with looking through a telescope. That some of the greatest astronomers of modern times, such as Kepler, Newton, Hansen, Laplace and Leverrier scarcely ever looked through a telescope as astronomers, is not generally understood. For two thousand years astronomy has furnished the great geometers of the world with many of their profoundest problems, and thus has advanced hand in hand with mathematics. It borrows its fundamental data from observation, but the elaboration and development of its results taxes the powers of the mathematical investigator. The work of making the necessary observations is so much easier than that of developing the mathematical theories to which they give rise, that the latter is comparatively neglected alongside the former. It is lamentable to see what a collection of unused observations are found in the pages of scientific periodicals, to say nothing of those which have remained unpublished in the records of observatories. Under these circumstances it is not worth while to found any more observatories for the prosecution of geometrical astronomy, except under special conditions. Among these conditions we may enumerate the following:—

1. The institution should have such an endowment as to secure the continuous services of two or three observers, and to publish at least the results of their observations in a condensed form.

2. The instruments should be of the finest class, but not necessarily of large size. This is not a difficult condition to fulfil, since such instruments are not very costly. One reason for observing it is that it is only within the last few years that the highest perfection has been attained in the construction of instruments of measurement.

If these two conditions can be really fulfilled, it is very desirable to add a few more to the great number of meridian circles now in existence, for the simple reason that it is easy to exceed them in perfection. It is, however, to be remarked that a good climate is a scientific pre-requisite for the success of an observatory of any kind. The value of observations is decidedly lessened by the breaks in their continuity due to the intervention of clouds. It is therefore extremely desirable that, so far as possible, new observatories should hereafter be erected under sunny skies.

If an observatory is to be devoted to physical research, a more modest outfit, both in the way of endowment and of instrumental means, may be sufficient to serve an excellent purpose. Instead of being a great co-operative work, requiring the continuous labour of several persons, physical research may be divided up into sections almost as small as we please, each of which may be worked by an individual astronomer with any instrument suited to the purpose in view. To the success of such an observatory a clear sky is even more necessary than to one engaged in measurement. Whether a great telescope will be necessary, will depend principally upon what is to be done. The consideration which is really of the first importance is the astronomer. The man who is really wanted will do more with the most inexpensive instruments than another one with the most costly ones. As already remarked, physical research is mainly the work of the individual, and what we want is to secure the services of the ablest man and then supply him with such means of research as are necessary to the problems he has in view. New questions are arising so frequently, and the field of physical research is now so wide, that it is impossible to lay down any general rules for a physical observatory, except that means should be furnished for supplying the investigator with any instrument he may want.

A third class of observatories are those intended for instruction in astronomy. The requirements in this direction are so different from those necessary to research that it is impossible to combine the highest efficiency in both directions with the use of the same instruments. The number of observatories especially designed for pure instruction are very few in number. The instruments necessary for the purpose are of the simplest kind; indeed, so far as mere training is concerned, the engineer's level, transit, and theodolite can be made to serve most of the purposes of the astronomical student. What the latter really wants is that training of the eye and the mind which will enable him to understand the theories of instruments, the methods of eliminating the errors to which they are subject, and the mathematical principles involved in their application. In this, as in nearly every department of professional education, we may lay it down as a rule that the wants of a liberal and of a professional education are, so far as the foundation is concerned, identical. We are too prone to lead the student into the minute details of a subject without that previous training in first broad principles which, though it may not immediately tell on his progress as a student, will be felt throughout his life to whatever field of work he may devote himself. Such a transit instrument as Hipparchus might have made—a wooden level mounted on an axis and supplied with slits to serve the purpose of sights—properly mounted in the meridian, could well be made to take the place of the transit instrument for purposes of instruction. Scarcely any higher skill than that of a cabinet-maker would be required in its construction. The object at which the student should then aim would be, with the aid of this instrument, to determine the error of his clock or watch within a few seconds. If he is really acquainted with the principles of the subject, and has his eyes properly trained, he will have no difficulty in soon learning to do this. SIMON NEWCOMB

NOTES

THE following details regarding the sad accident by which Prof. Balfour lost his life have been received since Prof. Foster's article was written. It appears (from a letter from Mr. C. D. Cunningham to the *Times*) that on the 14th ult. Mr. Balfour crossed the Col du Géant, and on descending on the Italian side the idea first occurred to him of attempting the Aiguille blanche de Peuteret, or, as it is sometimes called, the Aiguille de la Belle Etoile, a peak which is one of the buttresses of Mont Blanc, to the *massif* of which it is joined by an extremely steep snow *arête*. Mr. Cunningham's guide, Emile Rey, had previously attempted the peak, and was able to give Mr. Balfour many details as to the probable line of ascent. Having failed, however, to persuade Mr. Cunningham and the guide Rey to accompany him, Mr. Balfour started from Courmayeur on Tuesday, the 18th, with the guide Johann Petrus, for Aiguille, accompanied by a porter to carry blankets and wood as far as their sleeping-place on the rocks. It was thought, the ascent being new and difficult, he might be absent two nights, and return to Courmayeur on Thursday. As he did not reappear, it was thought he must have crossed to Chamounix, or gone down to the Chalets de Visaille for more provisions. On Friday Mr. Bertolini and Mr. Baker, at the hotel in Courmayeur, became seriously alarmed, and finding the party had not been heard of either at Chamounix or at the Chalets de Visaille, they sent out a search party, which, early on Sunday morning, on reaching the rocks between the Glacier de Brouillard and the Glacier de Freny, found the bodies of Mr. Balfour and Petrus, both partly covered with snow, at the foot of the steep snow *arête*. As there was little fresh snow about the place, it was probably not an avalanche that caused their death. One may have slipped, and the other not had sufficient strength to hold his companion. The provisions at the sleeping-place having been untouched, the accident must have taken place on Wednesday, the 19th. But it is not certain whether they fell in descent or ascent. Means were taken on the 25th to have the remains brought to the hotel.

THE three missions designated for observation of the Venus transit in Patagonia left on the 20th ult. in the Messageries steamer from Bordeaux, for Buenos Ayres. The arrangement is as follows:—*Rio Negro* (41° S.), M. Perrotin, director of Nice Observatory, accompanied by Lieutenants Tessier and Delacroix, and M. Guénaire, photographer to the Observatory; *Chubut* (43° S.), M. Hatt, hydrographic engineer, assisted by Lieut. Leygue and M. Mion, engineer; *Santa Cruz* (50° S.), Capt. Fleuriais, assisted by Lieutenants Le Pord and de Royer de Saint Julien, and M. Lebrun, naturalist. Arrived at Monte Video, the first two missions will probably embark in the advice boat *La Bourdonnais*, the third in the advice boat *Le Volage*. In the course of observations, detachments from the *Volage* will try to ascend the Rio Santa-Cruz at least to the point reached by Darwin in the *Beagle* expedition. The Chili mission, composed of Lieut. de Bernardière, assisted by Lieut. Barnaud and Ensign Favereau, embarked on the 15th ult. in an English steamer going by the Straits of Magellan.

UNDER the name of a "North German Museum for Natural Science" Dr. G. Haller and Cie have opened at Putbus, on the island of Rügen, a storehouse of natural objects and aids to teaching, whence schools, museums, and private individuals may obtain specimens and collections, representing all the three kingdoms of nature. An institute for investigation of the Baltic forms part of the scheme, and a few students have been enrolled, we learn, for the current summer. Dr. Haller was formerly a privat-docent of zoology in Berne. With the aid of a well-known entomologist, collections of insects of all kinds (exotic included) are furnished; also biological collections of caterpillars, larvæ, pupæ, parasites, &c. It is intended, later on, to supply collections of the insect pests of agriculture. The utensils of entomologists and other apparatus are also provided. Of European mammals, birds, reptiles, amphibia, fishes, &c., many specimens are kept, preserved in the usual way; also preparations for the study of embryology and comparative anatomy, and for varied microscopical work. A variety of live animals for aquaria and terraria are provided. The dry preparations of frogs and other animals obtained by a modification of Semper's method have received special commendation, also the series of embryos and parasites.

FREE libraries do not increase in number so rapidly in England as in America, where they have now reached to 4000. Yet a pamphlet or circular issued by the Bureau of Education must be of considerable interest to any who are engaged in starting or working libraries. It points out the disadvantages of the arrangements of existing library buildings, and gives a general plan by which they may be avoided. The chief American libraries consist of large halls open from floor to roof and surrounded by galleries five or six one over another like a theatre. The author of this paper (Mr Poole of Chicago) objects to this general plan, on account of (1) the waste of this central space, or if this central space is used for reading, for its publicity and noisiness; (2) the difficulty of getting any uniform temperature over the whole of such a building, for while the lower floors are kept at a mild warmth the upper floors become so intensely hot that not even an attendant can work there, and the bindings perish from heat; (3) the wasteful expenditure of the physical strength and time of attendants in going upstairs and round from one part of the library to another; (4) the special convenience for catching fire where all communicate with one centre instead of being divided into fireproof compartments; (5) the difficulty of enlarging such a circular building, as the principal American libraries already require enlarging; and (6) its great expense. In the plan which Mr. Poole suggests ten rooms surround a square space equal to only two of the rooms. Each room should be about 16 feet high, thus easily warmed uniformly. Books should be classified, and in a few cases duplicate copies kept so that a student should find all the books on the subject he wanted in one room, and there should be no journeying to distant galleries; of course where a library is so small that all its books can be stored in one room a great difficulty is avoided. Each room being separate and all being built of fireproof material and only communicating by a light iron gallery, which goes round the central area, they are both quiet and fireproof. In each room a row of reading tables will stand under the windows at one end, and the remaining space will be covered with double shelves, not more than 7½ feet high, with passages 3 feet or 3½ feet wide between. No ladders will thus be required, and the high temperature will be avoided. Yet twenty-five volumes to every square foot of flooring can be stored in this way, and hence a room 40 feet × 40 feet will hold 40,000 volumes; ten such rooms on a floor give 400,000 volumes, and five storeys high will hold 2,000,000.

MR. CLEMENT L. WRAGGE has written to the *Times* earnestly entreating all visitors to Ben Nevis to co-operate with him and the Scottish Meteorological Society to prevent damage to the instruments on the mountain. These are, of course, kept under lock and key, and till lately all has gone well with them. But on the morning of July 23 it was found that wanton mischief had been done to the intermediate station at the Red Burn Crossing, about 2700 feet above the sea. A hole had been made in the thermometer box, the louvre forced off, and the wet bulb thermometer forced from its screws, and broken. The compass points had also been removed. It seems difficult to account for such acts. Mr. Wragge's appeal to the British public will not, we trust, be in vain.

IN connection with the forthcoming electro-technical exhibition in Munich, the Bavarian Kunstgewerbe-Verein has announced a prize competition for light-fittings (lustres, brackets, candelabra, &c.) suitable for the electric light. The Edison illumination, to be maintained by about 80 horse-power, will be no way inferior in extent to that in Paris; the restaurant-hall, with garden, library, and reading room, one or two streets, and the theatre, will be lit with 800 Edison lamps of various strength, from 8 to 100 candles. Mr. Edison's plans for centrally lighting up a whole city quarter with 14,000 lamps of 170,000 total candle-power will be shown; the system is to be tried in New York. Schuckert, of Nürnberg, will, from the roof of the crystal palace, light up the Frauenthürme with a reflector lamp of 10,000 candle-power; also the temporary theatre with an upper light of 4000 candle-power; he will also exhibit several transportable electric lights for war purposes, railways, &c. Special interest will attach to an effort to utilise the water-power of the Hirschau, about three miles from the palace; the current will work a lift or thrashing machine in the palace by day, and illuminate the garden and the Königsplatz by night (11 lamps of 1000 candle-power each). The copper wire will be 3 mm. thick. A provisional plan of the Exhibition is supplied with the *Electrotechnische Zeitschrift* for July.

THE Council of University College, London, have accepted a fund raised in memory of Miss Ellen Watson, a former student. A Memorial Scholarship consisting of the income of the fund is open to students of either sex who display very marked merit in applied mathematics.

THE *Herald* (N.Y.) correspondent with the party in search of the lost crew of the *Jeannette* has been impressed by the beauty of the teeth of natives of Northern Siberia. He saw old men of sixty and seventy with sets of teeth small and pearly white, polished and healthy. Decay and suffering are unknown. A physician of Yakutsk attributed this to the habits and the kind of food eaten by the natives, and to a certain care taken by them from childhood up. First, the natives do not touch sugar in any form, for the simple reason that they cannot afford to buy it. Secondly, they are in the habit of drinking daily large quantities of fermented sour milk summer and winter, which is antiscorbutic, and is very beneficial in preserving the teeth. And lastly, they have the habit of chewing a preparation of the resin of the fir tree, a piece of which, tasting like tar, they masticate after every meal, in order specially to clear the teeth and gums of particles of food that may remain after meals. The gum or resin is prepared and sold by all apothecaries in Siberia, and is much used by Russian ladies.

THE International Committee of the Red Cross Society of Geneva have recently offered a prize of 2000 francs for three studies (to be complementary of each other), on the art of improvising means of help for the wounded and sick; the first to relate to the production of means of treatment, the second to means of transport, the third to the sudden providing of an ambulance or a field-hospital. Papers to be sent in before April 1, 1883.

MM. HACHETTE AND CO. will publish in a few weeks the first volume of a new series—"Les Drames de la Science"—entitled "La Pose du Premier Cable"; the author is M. W. de Fonvielle.

FROM Signor Ricco's report on latitudes of groups of sun-spots in 1881, it appears that 258 groups or formations of spots and cavities were observed (82 presenting only cavities). The groups of the northern hemisphere seemed to have longer duration; more of them reappeared after one or more rotations. They were also richer in spots. The groups of latitudes under 15° were always displaced towards the equator, those of latitudes over 15° towards the poles. The development of groups is more rapid than their disappearance. The distribution was:—In the northern hemisphere, 132 groups in a zone of 22° between +7° and +29° with a maximum at +20°; in the southern, 126 groups in a zone of 30° (therefore broader) between −3° and −33°, maximum at −18°, more pronounced than in the other hemisphere. The centres of the two bands of spots was at the same latitude, 18°. The band without spots or cavities, between the other, was about 10° in breadth, with centre at +2°. In the northern hemisphere the greatest duration belonged to the groups in the lowest latitudes (generally the groups richest in spots and most durable are at the latitudes of maxima).

FOR determination of high temperatures at the Imperial Porcelain Manufactory in Berlin, pyroscopes of noble metal have been long used with the best success; the materials are pure silver and gold, silver alloys with 20, 30, 40, 60, and 80 per cent. of gold, and gold-platina alloys with 5, 10, or 15 per cent. platina. Silver-platina alloys are objectionable, because at high temperatures the silver is very volatile, so that the composition changes. Also alloys of gold with more than 15 per cent. platina are not used, because they do not suddenly melt down; but an alloy richer in gold separates out, while a skeleton richer in platina remains, to melt at a higher temperature. For the measurement with alloys, balls of 1 to 2 gr. weight, between parchment paper, are hammered on the anvil to about the thickness of a penny-piece; the pieces are bent so that they can stand upright, and placed in rows, arranged according to melting-point in small cupels of clay, magnesia, or bone-ash, in such a way that they can be seen from without, through a hole. For a new experiment they have merely to be flattened out again, and put into the same cupel. In this way temperatures from the melting-heat of silver to nearly that of cast-steel can be determined pretty exactly.

WE have received "Fragments of the Coarser Anatomy of Diurnal Lepidoptera," by Mr. Samuel H. Scudder, being an account of dissections of caterpillars and chrysalids of butterflies; it is issued partly with the view of calling attention to the need of work on a subject which is very imperfectly known at present. The "Studies from the Biological Laboratory" of the Johns Hopkins University for June, contains original matter relating to the pulse wave in the coronary artery, the influence of digitaline on the heart, polar action in nerves, temperature and reflex actions, &c. A reprinted memoir by Staff-Commander Tizzard, R.N., and Mr. John Murray, on "Exploration of the Faroe Channel during the Summer of 1880 in Her Majesty's hired Ship *Knight Errant*," with various subsidiary reports, has also reached us, and we hope soon to refer to its contents.

"THE Photographic Studios of Europe," by Mr. H. Baden Pritchard (London: Piper and Carter) gives copious information that the professional photographer will appreciate and find helpful, but has also much to interest the general reader. It is the outcome of a house-to-house visitation of the principal studios in Europe, and a record, in colloquial style, of the practice observed. For convenient reference the information is tabulated in the introductory chapter, under nine headings (the reception-room, the studio, the dark room, &c.), and the names of the photographers follow, in each case, with the page-numbers. Among matter of a special nature we note accounts of photographing prisoners at Millbank and Pentonville, and at the Prefecture of Police in Paris; also a popular account of Dr. Huggins' photographs of the Stars.

SIGNOR MAUDELIN affirms that the violets *V. syrtica*, *V. tricolor*, and *V. arvensis* contain from 0·083 to 0·144 per cent. of salicylic acid. The other species contain none; at least no appreciable quantity. The wild violet has much more than the tricolor. It is the action of salicylic acid that explains the use of the violet in pharmacy.

MR. W. B. COOPER has lately brought before the Franklin Institute a device for increasing the dynamic effect of the vibrations of diaphragms. To one end of a wire or band he attaches a diaphragm or other pulsating body; the wire is passed a half turn or several turns round a drum or pulley, which is rotated towards the diaphragm. To the other end may be attached a lever having a point adapted to indentation of sheet metal passed under it at uniform speed. With such an arrangement (called a "phonodynamograph") Mr. Cooper has embossed brass of the thickness of writing paper by impact of the voice on a diaphragm like that of the phonograph. (The force of the pull is augmented by force derived from friction on the surface of the pulley). The principle is applicable to the telephone, both for increasing the intensity of the electric impulses transmitted, and augmenting their effects at the receiving station, and Mr. Cooper shows how this may be advantageously done.

THE northernmost place in the world where rye and oats mature is at Kengis, in the Swedish province of Norrbotten, 49 miles to north of the Polar Circle, whereas the northernmost spot where corn is grown is at Muoniovara, 98 miles to north of the Circle. The rye yields, it is stated, 98 per cent., and the oats about 90.

THE additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from West Africa, presented by Mrs. Cumberleye; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mr. W. K. Stanley; four Egyptian Ouarans (*Psammosaurus scincus*) from Egypt, a Horseshoe Snake (*Zamenis hippocrepis*), eleven —— Snakes (*Zamenis ventrimaculatus*), an Ocellated Sand Skink (*Seps ocellatus*), South European, presented by Messrs. Wylde Beyts and Co.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; a Spotted Bower Bird (*Chlamydodera maculata*) from South Australia, a White-billed Parrakeet (*Tanygnathus albirostris*) from Celebes, a Yellow-billed Sheathbill (*Chionis alba*), captured at sea, off Cape Horn; a Shag (*Phalacrocorax cristatus*), North European, a Cornish Chough (*Fregilus graculus*), British, four Eyed Lizards (*Lacerta ocellata*), South European, purchased; a Humboldt's Lagothrix (*Lagothrix Humboldti*) from Upper Amazon, received in exchange; five Undulated Grass Parrakeets (*Melopsittacus undulatus*), a Geoffroy's Dove (*Peristera geoffroii*), bred in the Gardens. The following insects have emerged during the past week in the Insect House:—Silk Moths: *Telca promethea*; Butterflies: *Vanessa antiopa*, *Vanessa polychlorus*, *Vanessa io*, *Melanagria galathea*, *Gonoepteryx rhamni*, *Thecla betulæ*, *Erebia blandina*, *Hipparchia janira*; Moths: *Deilephila euphorbiæ*, *Bombyx castrensis*, *Liparis monacha*, *Liparis dispar*, *Chelonia caja*.

OUR ASTRONOMICAL COLUMN

CONTINENTAL OBSERVATORIES.—The last number of the *Vierteljahrsschrift der Astronomischen Gesellschaft* contains reports of the proceedings of some twenty of the observatories on the continent during the year 1881. At Berlin observations for the zone + 20° to 25°, were actively continued, upwards of 10,000 being made in the year. The 9-inch refractor was employed for comets and small planets, &c., the physical appearances of the comet 1881 III. receiving special attention. With the Declinograph 1200 small stars were observed, making, up to the end of 1881, 12,329 stars, mostly from the eleventh to the thirteenth magnitudes, thus determined, in connection with the identification and observation of the small planets. At Bonn the southern "Durchmusterung" furnished observations of upwards of 14,000 stars, so that rapid progress is being made with this work under the direction of Prof. Schönfeld. At Brussels astronomical physics, as well as meridian observations, have been attended to; the meteors of the August period were extensively observed over Belgium; Christiania was mainly occupied, under Dr. Fearnley, with the zone 65° – 70°, and the curious circumstance of the existence of four variable stars in this zone within a radius of 1° is recorded, the first in 20h. 59m. 20s. + 66° 8′·5, has been estimated by various observers from 5m. (Lalande) to 9m. (Argelander), the second is in 20h. 59m. 48s. + 67° 35′·9, the third in 21h. 7m. 33m. + 67° 54′·4, and the fourth in 21h. 11m. 49s. + 66° 0′·9, for 1855·0. Baron v. Engelhardt, at Dresden, has zealously observed the various comets of the year, and has made 111 observations of 19 minor planets, the principal instrument in the Baron's observatory is an equatorial refractor by Howard Grubb, of Dublin, aperture 306 mm. A new physical observatory has been erected at Herény, Hungary, by Eugen and Alexander von Gothard, the position of which is 12m. 49·8s. east of Berlin, with latitude 47° 16′ 37″; the observatory is provided with a 10¼ inch equatorially mounted reflector by Browning, of London, observations were commenced in the second week of November, and chiefly consisted of the examination of star-spectra. At Keil an 8-inch refractor by Steinheil has been received: meridian observations here were largely devoted to circumpolar stars + 79° to 82°, but according to the present plan, the observations will be continued to the pole. Leipsic is now under the direction of Prof. H. Bruns. At Lund the zone undertaken by the observatory was continued, more than 5200 stars being determined. From the Observatory of Brera, Milan, Prof. Schiaparelli makes the welcome announcement that the late Baron Dembowski had confided to him all his astronomical manuscripts with the condition that they were to be utilised to the best advantage for the science. His measures of double stars, upwards of 20,000 in number, will be published under the auspices of the Accademia Reale dei Lincei; they are to form four volumes, of which the first will contain the measures made by Dembowski at Naples with his Plössl Dialyte in the years 1852-58; the second and third, the observations made at Galarate on stars of the Dorpat Catalogue, and the fourth, the measures of stars in W. Struve's appendix, the Pulkowa Catalogue, and double stars discovered by other astronomers, more especially by the eminent American observer, Mr. Burnham. The first volume is in course of preparation. At Plonsk Dr. Jedrzejewicz continues, in his private observatory, measures of double stars as his principal work. The passages of the red spot on Jupiter, by the middle of the disc, were micrometrically determined from November 25, 1880, to February 5, 1881, from 174 rotations, the period was found to be 9h. 55m. 34·41s. ± 0·13s., and at the same time the jovicentric latitude of the centre of the spot was found – 22°·8, and its length in degrees of the parallel 26°·4; the third and fourth comets of 1881 and Encke's comet were also observed for position. The physical observatory at Potsdam was in full activity, and in addition to the more special subjects of observation undertaken by this important establishment, an extensive series of observations of variable stars was secured in 1881. From Stockholm Dr. Hugo Gylden notifies his determination of the parallax of the star Bradley 3077, or No. 240 in Argelander's Catalogue of 250 stars, forming part of the seventh volume of the Bonn observations: the resulting value is 0″·283 ± 0″·0468; this star has considerable proper motion. Prof. R. Wolf communicates, from Zurich, the monthly numbers of days with and without sun-spots, and the relative numbers: in the whole year's observing-days, the sun was free from spots on five days, and exhibited spots on 297.

ATOMIC ATTRACTION

THE theory of universal gravitation, as I understand it, asserts that the mutual attraction exerted by any two bodies, A and B, is dependent only on their respective masses and on the distance between them, being entirely uninfluenced by the presence of other bodies even in the immediate neighbourhood of A or B. Thus at a given moment the Earth and Venus, being in certain definite positions, exert upon each other a certain force of attraction; the attraction thus taking place between the masses of the two planets would be unaltered by the removal of the Moon from the sphere of action; the gravitation of the Earth and the Moon does not therefore tie up any portion of the attractive energy of the Earth, and so diminish the force with which other bodies gravitate towards it.

A totally different assumption is usually made with regard to that form of attraction which gives rise to chemical phenomena. Here it is supposed that two or more atoms, having combined together, have thereby become incapable, at any rate in the majority of cases, of attracting others to any appreciable extent. Thus I imagine that most chemists hold the view that when hydrogen and oxygen combine together to form water they thereby exhaust, or nearly exhaust, their combining power, that the power of attraction residing in the oxygen atoms is all concentrated upon the hydrogen atoms, just as we might conceive all the attractive power of the Earth concentrated on the moon, thus leaving all other bodies in its neighbourhood free from the influence of gravity. We thus invest matter with two separate forms of attraction differing entirely in their mode of action, and having indeed nothing in common. It is however possible to a certain extent to assimilate chemical attraction and gravitation, and I propose here to discuss some of the results which ensue from the elaboration of this idea Let us suppose then that the act of chemical combination in no wise alters the power of attraction which the combining atoms exert upon surrounding bodies, and let us see what effect this hypothesis has upon the explanation of various phenomena. In order to do this we must first render as precise as possible our notions of the construction of chemical compounds.

It is now known with certainty that the atomic and molecular volumes of substances are but slightly altered by combination, that is to say, that under comparable conditions the atom of any substance generally occupies about the same space with whatever atoms, similar or dissimilar, it may be combined. This fact seems to me to point to the conclusion that the atoms which make up a molecule are as close together as their periodic motions will permit, and are not merely held in certain positions of equilibrium by various opposing forces; for if the latter supposition were true, I fail to see how it would be possible for the same atom, together with its surrounding proportion of space, to have always the same volume. The immediate proximity of the several molecules in the liquid and solid states must also be assumed, in order to account for the invariability of molecular volumes.

The innumerable facts which have been brought to light by the efforts of those who have investigated the chemistry of the carbon compounds all lead one to suppose that there is some foundation for the ideas propounded by chemists concerning the position of the atoms, and that the constitutional formulæ ascribed to organic substances really represent the construction of the molecule. If this be so it certainly furnishes a further argument in support of the proximity of the atoms.

The assumptions contained in the preceding paragraphs are in no way opposed to the views generally held concerning molecular and atomic motion which we owe to the development of the science of heat. They merely state that there is no force of repulsion exerted between contiguous atoms, and that the vibratory or other movements are small compared with the size of the moving masses.

The object of the following remarks is to show that the hypothesis concerning chemical attraction mentioned above enables us to offer some explanation of the relative volatility of bodies. We all, I presume, look upon the maximum vapour tension of a substance at a given temperature as affording to a certain extent a means of estimating the attraction which its molecules exert among themselves; if there is considerable attraction there will be a low vapour tension, and with little attraction there will be a low boiling point. It follows from this that the attraction between the molecules of hydrogen is relatively extremely small; that in the case of oxygen and nitrogen it is also very small, though probably much larger than in the former case; the attraction mutually exerted by molecules of chlorine will be more considerable; while with bromine, iodine, and other liquid and solid elements it will be greater still. We must not however confound the attraction exerted between *atoms* of a substance with that between the *molecules*, for each atom attracts separately those of the contiguous molecule, so that the attraction between two molecules of bromine, for example, will be four times as great as between two atoms, and generally when the molecule of a substance contains n atoms the attraction between two molecules will be approximately n^2 times that between two atoms. This is of course even approximately true only when the distance between the two molecules is great relatively to their size; when the two molecules are close together the several interatomic attractions will be exercised over very different distances, and will therefore be very unequal in amount. Nevertheless, the above remark enables us to see that in some cases the apparent attraction, as estimated by the boiling-point, may be very misleading. In sulphur, for example, of which the molecule in the solid and liquid states is probably somewhat complex, we have a substance of high boiling-point, though the mutual attraction of the atoms may be comparatively small. The same is the case with carbon and many other substances.

Applying now the above considerations to a few actual cases, we shall see that the relative volatility of different substances is generally satisfactorily explained. Let us designate by (hh) the attraction at unit distance between two atoms of hydrogen, by (oo) the attraction between two atoms of oxygen, and generally by (rs) the attraction at unit distance between any two atoms, R and S. Then in the case of water the molecular attraction will be represented by—

$$4\mathrm{A}(hh) + 4\mathrm{B}(ho) + \mathrm{C}(oo),$$

where A, B, and C are factors dependent on the distances which separate the atoms; now we have seen that (hh) and (oo) probably have small values, but (ho) is not small, hence the attraction between molecules of water should be far greater than that between molecules of oxygen, and the boiling-point much higher, a result which is in accord with fact. The boiling-point of water would probably be much higher than it is, were it not that the attractions between H and O are exerted over comparatively large distances, owing to the hydrogen of one molecule shielding its companion oxygen from the approach of other hydrogen. In the similarly constituted body, H_2S, the value of the molecular attraction will be—

$$4\mathrm{A}(hh) + 4\mathrm{B}(hs) + \mathrm{C}(ss),$$

in which expression A, B, and C may be supposed to have values not differing excessively from those which hold good in the case of water (the sulphuretted hydrogen being supposed liquid). The value (ss) is in itself small, and since the force is exerted between two atoms which cannot approach each other very closely, C is also small. The affinity of hydrogen for sulphur being also feeble, the whole value of the molecular attraction is small; sulphuretted hydrogen should therefore be an extremely volatile body, which is actually the case.

With hydrochloric, hydrobromic, and hydriodic acids we have for the molecular attraction the several values—

$$\mathrm{A}(hh) + 2\mathrm{B}(hcl) + \mathrm{C}(clcl)$$
$$\mathrm{A}'(hh) + 2\mathrm{B}'(hbr) + \mathrm{C}'(brbr)$$
$$\mathrm{A}''(hh) + 2\mathrm{B}''(hi) + \mathrm{C}''(ii).$$

As the three bodies are similarly constructed we may assume that A, A′, A″, &c., do not materially differ. As the third terms of these expressions increase the second terms diminish; we should therefore expect that there might be no great difference in the vapour-tensions of the three substances; experiment proves that they may be liquefied with about equal facility. It should be noticed that the thermal change accompanying the formation of any one of these gases, HCl, for example, is not a true measure of the attraction between the atoms, since it also includes the heat employed in separating the atoms of the original molecules H_2 and Cl_2.

We may also find a confirmation of the above views in the many homologous series of organic chemistry. In the alcohols of the ethyl series, for example, the larger the molecules the greater must be the attraction between them, and consequently the higher the boiling-point; this, as is well known, is in accordance with fact. In the case of isomeric alcohols, the influence of the position of the atoms comes conspicuously to the fore. It is clear that if the atoms of carbon of two different molecules cannot approach each other so nearly in the case of one isomer as in another, the attraction between the molecules will be less, and the boiling-point consequently lower. Now in secondary and tertiary alcohols the carbon atoms are more sheltered by each other, are, as it were, more removed from the exterior of the molecule than in primary alcohols; at the same time the boiling-points are lower, which is as it should be.

If we replace two atoms of hydrogen in an alcohol by one of oxygen we increase the attraction of the molecules, since we substitute a certain number of attractions $(h\,o)$ and $(c\,o)$ for the relatively small attractions $(h\,h)$ and $(c\,h)$; the increase of boiling-point which we should expect is confirmed by experiment. Many other examples might be brought forward, were it not that their discussion would transcend the limits of this article.

Before concluding I should like to draw attention to one question which is of importance. The use of the above hypothesis renders it difficult at first sight to account for the formation of definite chemical compounds; it seems that if any number of atoms of hydrogen are equally attracted by one of chlorine, the combination of one of them with that atom would not prevent the adherence of a second and a third forming H_2Cl, H_3Cl, &c. This difficulty is avoided by supposing that the chlorine atom is of such a form that only one atom of hydrogen can approach sufficiently closely to adhere permanently; such forms are difficult to imagine, though it may be remarked that an atom in the form of a ring offers in a certain sense a unique position to another which instals itself inside it. The existence of molecular compounds proves that the permanent adherence of other atoms is sometimes possible, and thus affords material support to the notion that the chemical affinity of an atom is not only exerted upon those atoms with which it is combined, but upon all others in its vicinity. FRED. D. BROWN

The Museum, Oxford

THE GESTURE SPEECH OF MAN[1]

ANTHROPOLOGY tells the march of mankind out of savagery, in which different peoples have advanced in varying degrees, but all started in progress in civilisation from a point lower than that now occupied by the lowest of the tribes now found on earth. The marks of their rude origin, retained by all, are of the same number and kind, though differing in distinctness, showing a common origin to all intellectual and social development, notwithstanding present diversities. The most notable criterion of difference is in the copiousness and precision of oral speech, and connected with that, both as to origin and structure, is the unequal survival of gesture signs, which it is believed once universally prevailed. Where sign-language survives it is, therefore, an instructive vestige of the prehistoric epoch, and its study may solve problems in philology and psychology. That study is best pursued by comparing the pre-eminent gesture system of the North American Indians with the more degenerate or less developed systems of other peoples.

North America showed more favourable conditions for the development of gesture signs than any other thoroughly explored part of the world. In the pre-Columbian period the population was scanty, and so subdivided dialectically that the members of but few bands could readily converse with each other. The sixty-five families of the Indian language now known to have existed within the territory of the United States differed among themselves as radically as each differed from the Hebrew, Chinese, or English. In each of these families there were sometimes as many as twenty separate languages, differing from each other as the English, French, German, and Persian divisions of the Aryan linguistic stock.

The conditions and circumstances attending the prevalence, and sometimes the disuse, of sign-language in North America were explained. The report of travellers, that among Indians, as well as other tribes of men, some were unable to converse in the dark, because they could not gesture, is false. It is the old story of *aglossos* and *barbaros* applied by the Greeks to all who did not speak Greek, repeated by Isaiah of the "stammering" Assyrians, and now appearing in the term *slav* (speaker) as contradistinguished by the Russians from the Germans, whom they stigmatise as *njemez* (tongueless).

The theory that sign-language was the original utterance of mankind does not depend upon such tales or prejudices. After the immeasurable period during which man has been upon the earth, it is not probable that any existing peoples can be found among whom speech has not obviated the absolute necessity for gesture in communication between themselves. The signs survive for convenience used together in oral language, and for special employment when language is unavailable.

The assertions made that the sign language of Indians originated from some one definite tribe or region supposes its comparatively recent origin, whereas the conditions favourable to its development existed very long ago and were co-extensive with the territory of North America occupied by any of the tribes. Such a solution would only be next in difficulty to the old persistent determination to decide upon the origin of the whole Indian race, in which most people of antiquity in the eastern hemisphere, including the lost tribe of Israel, the gypsies, and the Welsh, had figured conspicuously as putative parents. Numerous evidences were presented as to its antiquity and generality. But the signs are not now, and from the nature of their formation never were, identical and uniform.

An argument for the uniformity of the signs of Indians was derived from the fact that those used by any of them were generally understood by others. But signs might be understood without being identical with any before seen. There was evidence that where sign language was found among Indian tribes it had become more uniform than ever before, simply because many tribes had for some time past been forced to dwell near together at peace. The process of the formation and introduction of signs was the same among Indians as often observed among uninstructed deaf-mutes when associated together. There was a similarity of development between the sign language of mutes and Indians. The longer and closer the contact between Indians while no common tongue was adopted, the greater would be the uniformity of signs. The inference that there was but one true Indian sign language, just as there was but one true English language, was not correct, unless it could be shown that a much larger proportion of the Indians who use signs at all, than present researches show to be the case, used identically the same signs to express the same ideas, and also because the signs are not absolute and arbitrary, as are the words of English.

Are these signs conventional or instinctive? Sign language, as a product of evolution, had been developed rather than invented, and yet it seemed probable that each of the separate signs, like the several steps that lead to any true invention, had a definite origin arising out of some appropriate occasion, and the same sign might in this manner have had many independent origins due to identity in the circumstances, or, if lost, might have been reproduced. In regard to arbitrary or natural sounds, no signs in common use were in their origin conventional, and what appeared to be conventionality largely consisted in the form of abbreviation agreed upon. When the signs of the Indians had from ideographic become demotic, they might be called conventional, but still not arbitrary. Yet, while all Indians, as well as all gesturing men, have many signs in common, they use many others which have become conventional in the sense that their etymology and conception are not now known or regarded by those using them. The conventions by which such signs were established occurred during long periods and under many differing circumstances. Our Indians, far from being a homogeneous race and possessing uniformity in their language, religions, and customs, differ from each other more than all the several nations of Europe, and their semiotic conceptions have correspondingly differed. To insist that sign language was uniform were to assert that it is perfect. He next went on to prove the general ancient use of the system in North America. This fact might be recognised among tribes long exposed to

---

[1] Address by Col. Garrick Mallery, U.S.A., Chairman of the Sub-Section of Anthropology at the American Association (Cincinnati).

European influence and officially segregated from all others. Collections had been obtained from the Iroquois, Ojibwas, Alaskans, Apaches, Tuni, Pimas, Papagos and Maricopas, after army officers, missionaries, Indian agents, and travellers had denied them to be possessed of any knowledge on the subject.

The studies so far pursued led to the conclusion that at the time of the discovery of North America all its inhabitants practised sign language, though with different degrees of expertness, and that while under changed circumstances it was disused by some, others, in especial those who, after the acquisition of horses, became nomads of the great plains, retained and cultivated it to the high development now attained.

Instances were presented of the ascertained permanence of some Indian signs, and those of foreign peoples and deaf mutes. Though they, as well as words, animals and plants, have had their growth, development, and change, those which are general both among Indian tribes, and are also found in other parts of the world, must be of great antiquity. Many signs but little differentiated were unstable, while others that have proved to be the best modes of expression have survived as definite and established.

The Indian system as a whole was compared with those of foreign peoples—the ancient Greeks and Romans and the modern Italians being first considered. His researches during several years showed a surprising number of signs for the same idea which were substantially identical not only among savage tribes, but among all peoples that used gesture signs with any freedom. This remark applied to the collections of signs already obtained by correspondence from among the Turks, Armenians, and Koords, the Bushmen of Africa, the Fijians, the Redjangs and Lelongs of Sumatra, the Chinese and the Australians. In comparing the Indian sign language with deaf mute signs, it was noticeable that the Indians who had been brought to the Eastern States had often held happy intercourse by signs with white deaf mutes, who surely had no semiotic code preconcerted with any of the plain roamers. Many of their signs were identical, and all sooner or later were mutually understood. The result of all these comparisons was that the so-called sign language of Indians was not, properly speaking, one language, but that it and the gesture systems of deaf mutes and of all people constituted together one language—the gesture speech of mankind—of which each system is a dialect.

The most interesting light in which Indians, as other lower tribes of men, are to be regarded is in their present representation of the stage of evolution once passed through by our ancestors. Their signs, as well as their myths and customs, form a part of the palæontology of humanity. Their picture writings are now translated by working on the hypothesis that their rude form of graphic representation, when at the same time a system of idiographic gesture signs prevailed, would probably have been connected with the latter. Traces of the signs now used by the Indians are also found in the ideographic pictures of the Egyptian, Chinese, and Aztec characters.

Signs often gave to spoken words their first significance, and many primordial roots of language are found in bodily actions. Examples were given of English, Indian, Greek, and Latin words in connection with gesture signs for the same meaning, and the structure of the sign language was compared with the tongues of this continent, and with reference also to old Asiatic and African languages, showing similar operations of conditions in the same psychologic horizon.

The most obvious application of sign language for its practical utility depended upon the correctness of the view submitted, that it is not a mere semaphoric repetition of motions to be memorised from a limited traditional list, but a cultivable art, founded upon principles which can be readily applied by travellers. The advantage was not merely theoretical, but had been demonstrated to be practical by a professor in a deaf-mute college, who, lately visiting several of the wild tribes of the plains, made himself understood among all of them without knowing a word of any of their languages, and by another who had a similar experience in Italy and Southern France.

The powers of sign language were then compared with those of speech. It finds actually in nature an image by which any person can express his thoughts and wishes on the most needful subjects to any other person. Merely emotional sounds may correspond with merely emotional gestures, but whether with or without them would be useless for the explicit communication of facts and opinions of which signs themselves are capable. Notwithstanding frequent denials, they do possess abstract ideas. The rapidity of communication is very great, and can approach to that of thought. Oral speech is now conventional, and with the similar development of sign-language conventional expressions could be made with hands and body more quickly than with the vocal organs, because more organs could be worked at once.

But such rapidity is only obtained by a system of preconcerted abbreviations and by the adoption of absolute forms, thus sacrificing self-interpretation and naturalness.

Sign-language was superior to all others in that it permitted every one to find in nature an image to express his thoughts on the most needful matters intelligibly to any other person. The direct or substantial natural analogy peculiar to it prevented a confusion of ideas. Successful signs must have a much closer analogy and establish a *rapport* between the talkers far beyond that produced by the mere sound of words. If they had been elaborated by the secular labour devoted to spoken language, man could by his hands, arms and fingers, with facial and bodily accentuation, express any idea that could be conveyed by words. The very concepts of plurality, momentum, and righteousness could be clearly expressed by signs, and it is not understood why those signs could not have obtained their present abstract significance through the thoughts arising from the combination and comparison of other signs, without words. When highly cultivated, the rapidity of sign language on familiar subjects exceeds that of speech, and approaches to that of thought itself.

From the records of the ancient classic authors and also from the figures on Etruscan vases and Herculanean bronzes and other forms of archaic art, it is certain that a system of gesture-language is of great antiquity. Later, Quintilian gave elaborate rules for gesture which are specially notable for the significant disposition of the fingers still prevailing in Naples. The ancient and modern pantomimes were discussed, and also the gestures of speaking actors in the theatres, the latter being seldom actually significant or self-interpreting even in the expression of strong emotion. The same scenic gesture must apply to many diverse conditions of fact. Its fitness consists in being the same which the hearer of the expository words would spontaneously assume if yielding to the same emotions, and which, therefore, by association tends to induce sympathetic yielding. But the facts themselves depend upon the words uttered. A true sign-language would express the exact circumstances with or without any exhibition of the general emotion appropriate to them.

It is necessary to be free from the vague popular impression that some oral language of the general character of that now used by man is "natural" to man. There is no more necessary connection between ideas and sounds, the mere signs of words that strike the ear, than there is between the same ideas and signs for them which are addressed only to the eye. Early concepts of thought were of direct and material characters, as is shown by what has been ascertained of the radicals of language, and there does not seem to be any difficulty in expressing by gesture all that could have been expressed by those radicals.

It will be admitted that all the higher languages were at some past time less opulent and comprehensive than they are now, and as each particular language had been thoroughly studied, it had become evident that it grew out of some other and less advanced form. The discussion of philological subjects at the present day was varied by the suggested possibility that man at some time might have existed without any oral language. A proof of this assumption lay in the fact that uninstructed deaf mutes originated signs from time to time expressive of their wishes and ideas.

The doctrine of Archbishop Whately and Max Müller, that deaf mutes could not think until after instruction, was combated. No one now doubts that the deaf mute thinks after instruction either in gesture signs or in the finger alphabet, or more lately in visible speech. By this instruction he has become master of a new and foreign language, but that he obtained from signs. But no one can learn a foreign language unless he had one of his own, whether by descent or acquisition, by which it could be translated, and such translation could not even be commenced unless the mind had been already in action, and intelligently using the original language for that purpose. In fact the use by deaf mutes of signs originating in themselves shows a creative action of mind and innate faculty of expression beyond that of speakers who acquired language without conscious effort.

It may be conceded that after man had all his present faculties he did not choose between the adoption of voice and gesture, and never with those faculties was in a state where the one was used to the absolute exclusion of the other. The epoch, however, to which the present speculations relate is that in which he had not reached the present symmetric development of his intellect and of his bodily organs, and the inquiry is, Which mode of communication was earliest adapted to his simple wants and informed intelligence? With the voice he could imitate distinctively but few sounds of nature, while with gesture he could exhibit actions, motions, positions, forms, dimensions, directions, and distances, with their derivations and analogues. It would seem from this unequal division of capacity that oral speech remained rudimentary long after gesture had become an efficient mode of communication. With due allowance for all purely imitative sounds, and for the spontaneous action of vocal organs under excitement, it appears that the connection between ideas and words is only to be explained by a compact between speaker and hearer which supposes the existence of a prior mode of communication. This was probably by gesture. At least we may accept it as a clue leading out of the labyrinth of philological confusion, and regulating the immemorial quest of man's primitive speech.

SCIENTIFIC SERIALS

Verhandlungen des naturhistorischen Vereines der Preussischen Rheinlande und Westfalens, 1881. Zweite Hälfte.—We note here the following:—On some Anthozoa of the Devonian, by Prof. Schlüter.—The Stromatopora of the Rhenish Devonian, by Herr Bargatsky.—Geological sketch of a journey through Palestine and the Lebanon region, by Prof. von Rath.—On the building art of birds, reduced to its true value, by Prof Landois.—The beetle genus *Bruchus*, Linn., and especially *Bruchus pisorum*, Linn., by Herr Cornelius.—On new finds of saurian tracks in the Wealden Sandstone of the Bückeberg, by Herr Grabbe.—The Royal Mercury Works at Idria, by Herr Fabricius.—The zinc ore deposits of Wiesloch, by Herr von Decken.—Bone-remains from the Schipka Cave in Moravia, by Prof. Schaaffhausen.—Removal of an iron fragment from the eyeball with an electromagnet, by Dr. Samuelsohn.—Skulls from Kirchheim, by Prof. Schaaffhausen.—Influence of the use of transportable pneumatic apparatus on the circulation of a healthy man, by Prof. Finkler.—On a colossal femur of the horse, found in January, 1880, when removing part of a bank of the Wupper at Elberfeld, by Prof. Schaaffhausen.—On so-called cosmic dust from Dresden, by Prof. von Lasaulx.—New apparatus for continuous application of weak galvanic currents, by Prof. Finkelnberg.—On the earthquake of Ischia, March 4, 1881, by Prof. von Rath.—On eruptive gneiss in Saxony and Bavaria, by Dr. Lehmann.—Nerve-stretching; three cases, by Prof. Doutrelepont.

SOCIETIES AND ACADEMIES

LONDON

Aëronautical Society, July 17.—A paper, upon the action of the pectoral muscle in the flight of a bird, was read by Mr. Fred. W. Brearey. He said that it behoved all experimenters in flight to reduce their theories into a demonstrable form. It had often been stated for instance that the power exerted by a bird in its flight had been greatly exaggerated, but no one had hitherto proved his assertion. It was capable however of satisfactory proof by demonstrating artificially the action of the pectoral muscle, by the aid of which weight became an accessory to power. When the bird committed itself to the air the upward pressure in the wings stretched the elastic ligament, which formed part of the muscle, to such an extent as to allow of the bird gliding upon the air without any exertion. The weight of the bird was the measure of this elasticity. It was said by some that at least the bird must possess the power by the downward stroke of the wing to raise its own weight. But Mr. Brearey said that this was not an absolute necessity, because the reaction of this elastic ligament aided the force of the down stroke. He proceeded to verify his assertion by the action of a model, with wings of four feet spread, under which he had attached an elastic cord passing under the body of the model. Upon committal to the air this just allowed of the wings being expanded, so that the model would glide downwards. He then detached the cord and wound up his power, calling attention to the fact that he had wound the india-rubber strands thirty-two times. He showed however that although this was sufficient to create a vigorous flapping of the wing when held in the hand, yet when committed to the air it had not the power to give one downward stroke, and therefore it could only glide as before. Holding it again with the cord attached and the power wound up the same number of times, he showed that it was unable to flap the wing, because the two forces were exactly held in equilibrium. There was a third factor wanted before it could fly—and that was weight. The model being liberated, flight was well sustained, and upon being set free several times without being wound up any further, it appeared able to fly with a very weak power. The same thing was observable with another model, composed entirely of a loose surface thrown into a wave action—his own invention. Mr. Brearey remarked that this economy in flight can only be obtained by something of the nature of wing action, and must be wholly wanting in any apparatus actuated by the screw.

EDINBURGH

Royal Society, July 17.—Prof. Balfour, vice-president, in the chair.—Prof. Heddle read a paper on the sequence of rocks in the North-West Highlands, a point on which there had been and still was a great deal of controversy. The author had examined eighteen sections in the region around and to the north of Loch Maree, and had convinced himself that Murchison and Geikie were in the main correct. The succession of the rocks was found to be as follows:—Torridon Conglomerates, Lower Quartzite, Dolomite Series, "Logan" Rock, Upper Quartzite, Upper Gneiss. The dolomite does not extend so far west as the quartzite and Logan Rock, and is of no great lateral extent, but it stretches as a thin strip of shallow water deposit from end to end of the whole district.—Prof. Tait communicated a paper by Mr. Wm. Peddie on the rotation of plane of polarisation by quartz and its relation to wave-length. The spectrum of a ray of light which has been transmitted through the polariser, a piece of quartz, and the analyser, exhibits one or more absorption bands (the number depending upon the thickness of the quartz), which move along the spectrum as the analyser is rotated. By direct comparison of this spectrum with the ordinary solar spectrum in juxtaposition, the rotation for any Fraunhofer line can be estimated with considerable accuracy. The rotations were expressed in terms of the inverse even powers of the wave-lengths as far as the sixth.—Mr. W. W. J. Nicol, in a paper on the condition of ammonium salts when dissolved in water, explained the abnormal expansion of solutions of ammonium chloride and other ammonium salts by the partial dissociation on solution in water—an explanation suggested by the well-known fact that such salts become acid on boiling. This view of the matter seemed further to explain other anomalies in the behaviour of ammonium chloride solution—such for example as its surface tension investigated by Quincke, and its coefficient of absorption for carbon dioxide as determined by Mackenzie.—Mr. J. Y. Buchanan described a new form of solar calorimeter which he had used in Upper Egypt at the time of the last eclipse. The sun's rays were concentrated by suitable reflectors upon a glass tube, two inches long, which formed the upper end of a Liebig's condenser, and was mounted equatorially so as to follow the sun's motion. The heat was measured by the amount of water distilled in a given time. The results obtained were very satisfactory, agreeing with the results given by other methods.—Prof. Crum Brown read a continuation of the paper by Messrs. Laurie and Burton, on the heats of combination of the metals with the halogens, estimated from electromotive force observations. Their result for the heat of combination of zinc with iodine in the presence of water differed by barely 2 per cent. from Andrews' value. Other results did not agree so well; but this was hardly surprising where so many factors entered into the experiments. The most accurate method was no doubt to let a chlorine, iodine, or bromine cell with given poles run down in a calorimeter and estimate the heat so given out.—Professor Brown also communicated a long paper by Mr. W. L. Goodwin, on the nature of solution, in which the author made a careful investigation into the solution of chlorine in various liquids at different temperatures. Experiment showed that there was in many cases a temperature of maximum solubility, a fact which Mr. Goodwin explained as due to the formation at lower temperatures of a chlorine hydrate whose rate of increase of solubility with increase of temperature quite masked the simultaneous decrease of solubility of the gas until a temperature was approached at which the chlorine hydrate could no longer exist.—The second part of the description of new and little-known phanerogamous plants from Socotra, by Prof. Bayley Balfour, was received as read.—The chairman, in bringing to a close the hundredth session of the Society, gave a brief review of the session's work.

Berlin

Physiological Society, July 14.—Prof. Du Bois Reymond in the chair.—Dr. Friedländer spoke *à propos* of a paper by Dr. Baginski at the last meeting, on the cells of the stomach-wall, and presented some microscopical preparations. Dr. Brösicke gave a summary report on the results of his investigation of normal bone-tissue. With a very favourable preparation, a bone 200 years old, he could explain the nature of the "bone-corpuscles" observed in fresh bones, for he was in a position to inject them from the Haversian canals with a coloured mass. Thereby was proved the existence of lacunæ, which, by their outrunning parts, communicate with the Haversian canals. The entire bone-traversing system of cavities, lacunæ, their outrunners, and the canals, are inclosed in a proper skin, the limiting membrane, which Dr. Brösicke was able to isolate and investigate chemically. The limiting membrane hereupon showed reactions, which essentially distinguish it from the intercellular substance, and which entirely agree with the reactions of horn-tissue; it was therefore named the "Keratin-layer." The contents of the lacunæ are very different in different stages of development of the bone. In the embryo, the lacunæ are quite filled with protoplasm; later, the protoplasm retires from the intercellular substance, and a distinct interval between the latter and the protoplasm-cell can be observed; at this stage, probably, arises the "keratin-layer." At a further stage of development, the contents of the lacunæ are transformed into fat, the cells of which abundantly fill the cavities. The fat cells then fall asunder into detritus, which is gradually dissolved, so that the lacunæ remain empty, or, as the author supposes, filled with a gas, probably carbonic acid. The proper lime-containing bone-substance consists of fibres of the nature of connective tissue, which are bedded in lines in different directions, make up the layers of bone-material, and are held together by a structureless lime-containing cement-substance. This structure of the lime containing bone-tissue has been described before, and Dr. Brösicke has merely been able to confirm former data; but what is specially to be noted as new, among the results of the inquiry, is the demonstration of a limiting membrane clothing the entire system of cavities, and its keratin-like character.

Vienna

Imperial Academy of Sciences, July 6.—W. Biedermann, on the morphological changes of the lingual glands of the frog by stimulation of the glandular nerves.—H. Hammerl, on rainbows formed by liquids of different index of refraction.—F. Streintz, experimental researches on galvanic polarisation (first part).—R. Prescher, on the mucous organs of Marchantieæ.—G. Schmidt, on the internal pressure and energy of superheated steam.—S. Mayer, studies on the histology and physiology of the vascular system (preliminary communication).—T. V. Tanowsky, on the nitro-derivates of azobenzene-parasulphonic acid.—T. Kajaba, a contribution to the theory of polar planimeters used in practice.—F. Kreuter, a sealed packet with the inscription "On a new process of preservation of railway-sleepers."—T. Holletschek, on the orbit of the planet Ate (111).—G. Vortmann, on a new method for the direct determination of chlorine besides bromine and iodine.—Zd. H. Skraup, synthetical experiments on the chinoline series (part 4).—Zd. H. Skraup and G. Vortmann, on the derivates of dipyridyl.

Paris

Academy of Sciences, July 24.—M. Jamin in the chair.—The following papers were read:—New researches on the propagation of explosive phenomena in gases, by MM. Berthelot and Vieille. They study the behaviour of a great variety of mixtures, and find a very fair agreement between the theoretical velocity and that observed. The velocity of translation of the gaseous molecules, keeping all the kinetic energy which corresponds to the heat liberated, may be considered as a limit representing the maximum velocity of propagation. This velocity is diminished by contact of gases and other foreign bodies, also when the gas inflamed at first is too small and too quickly cooled by radiation, also when the elementary velocity of the chemical reaction is too weak (as with carbonic oxide).—Separation of gallium, by M. Lecoq de Boisbaudran. This relates to separation with cobalt, nickel, and thallium.—Dilator sympathetic nerves of vessels of the mouth and the lips, by MM. Dastre and Morat.—Theory of the diurnal motion of the axis of the earth, by M. Folie. He finds a diurnal precession and nutation which are far from insignificant and may become sensible to observation for circumpolars, even supposing the earth solid in the interior.—M. Faye made some remarks on Tom. I. of the Annals of the Observatory of Rio de Janeiro, sent by the Emperor of Brazil.—Observations of solar spots and faculæ, at the Royal Observatory of the Roman College, during the first half year of 1882, by M. Tacchini. The spots showed a secondary minimum in January, both in frequency and in size. There was increase till April, then rapid diminution. On no day were spots absent. The maximum will probably occur this year. The faculæ were pretty numerous from the first.—Latitudes of groups of solar spots in 1881, by M. Ricco (see Notes).—On the orbit of Japhet, by Mr. A. Hall.—Rapid solution of the problem of Kepler, by M. Zenger.—On the chemical work produced by the battery, by M. Tommasi.—The chromic acid couple as used by Favre (positive electrode platina) produces an exterior chemical work equal to about 65 calories. Substituting for the platina, carbon or spongy platina, one may get 20 calories more (*i.e.* about 85 calories).—On the variation of friction produced by voltaic polarisation, by M. Krouchkoll. He has found that polarisation by oxygen increases the friction, while polarisation by hydrogen diminishes. He describes his apparatus.—On the amplitude of telephonic vibrations, by M. Salet. On the iron plate of a Bell telephone were fixed two small glass discs giving Newton's rings. On speaking loudly to the telephone at 5m. or 6m. distance, the rings lose distinctness and disappear. To estimate the displacement by a continuous sound, a disc with slits was rotated before the instrument; with a certain velocity the rings return; and on then blowing through the disc, the sound proves to be in unison with that of the telephone. The amplitude of vibration of the telephone plate was estimated at two to three ten-thousandths of a millimetre.—Researches on the use of crusher-manometers, &c. (continued), by MM. Sarrau and Vieille. With the same density of charge, the maximum pressure of picrate of potash and dynamite are shown to differ considerably, though with one piston they had nearly the same crushing force.—Reproduction of calcite and of witherite, by MM. Miron and Bruneau.—On the vaporisation of metals in vacuo, by M. Demarçay. This was effected at comparatively low temperatures; the volatility of cadmium was proved at 160°, zinc at 184°, antimony and bismuth at 292°, lead and tin at 360°. The deposits in 24 to 48 hours were weighable (5 to 15 mgr.).—On the determination of astringent matters in wine, by M. Girard. He employs catgut, utilising its tendency to combine with those matters.—Law of congelation of benzenic substances in neutral substances, by M. Raoult. Acetones, aldehydes, ethers, hydrocarbons, and their derivatives, dissolved in a given weight of benzine in quantities proportional to their molecular weights, all lower the freezing-point of this liquid the same number of degrees.—Means of artificially conferring immunity against symptomatic or bacterian charbon, with attenuated virus, by MM. Arloing, Cornevin, and Thomas.—On Lieberkuehnia, a multinucleate rhizopod of fresh water, by M. Maupas.—On the fossil flora of Tong-King coal, by M. Zeiller.—New researches (physiological and therapeutical) on globularine, by MM. Heckel, Mourson, and Schlagdenhauffen. Globularetine is the purgative principle, and in a leaf-decoction the action is greater, on account of associated mannite.

CONTENTS

THURSDAY, AUGUST 10, 1882

THE BRITISH ASSOCIATION

SOUTHAMPTON is to have the honour this year (as no doubt most of our readers are already aware) of receiving the British Association for the Advancement of Science during its fifty second Annual Meeting, which will take place between the 23rd of August and the 1st of September. The selection of Southampton for this purpose is happy in many respects. The town has a history, and is in itself attractive. It is near the sea, it is well-built, it has beautiful surroundings; its Public Parks and its Common are no mean objects of interest, it has superior hotel, boarding and lodging accommodation, and, above all, it is excellently supplied, as we shall see below, with Public and other Buildings in which to hold the General and Sectional Meetings of the Association.

The proximity of Southampton to the Continent induces a hope of the presence of some of the most eminent men of science of France, Germany and other countries. Steps have been taken to secure this; and the visit of the distinguished foreigners will probably form one of the leading characteristics of the meeting.

The town and its immediate neighbourhood have always been found extremely attractive to visitors, especially during the months of August and September, when a very large number of yachts assemble for the purpose of taking part in the great regattas which are held at Cowes, Ryde, Portsmouth, and Southampton itself; whilst the beautiful scenery of the New Forest and the Isle of Wight can easily be enjoyed. It will be seen in the sequel that ample provision has been made by the Local Executive Committee in this direction.

To the Archæologist, Southampton presents much that is interesting, possessing as it does many remains of great antiquarian value,—for instance, the Bar Gate and the old Town Walls, Towers, &c., the birth-house of Isaac Watts, the site of the old Spa, and other ruins,—whilst on the banks of Southampton Water stand the ruins of Netley Abbey. Within very easy access of the town are the City of Winchester, with its Cathedral, its College, and the Hospital of St. Cross; the town of Romsey, with its noble Abbey Church; the city of Salisbury with its beautiful early English Cathedral, its Blackmore Museum, Old Sarum, Stonehenge, Cherbury, and Wilton Park; and the village of Beaulieu, in the New Forest, with the remains of Beaulieu Abbey. On the shores of the Solent is Hurst Castle, and a little beyond, the Priory of Christchurch. In the Isle of Wight are Carisbrooke Castle, the remains of a Roman villa in the village of Carisbrooke, and the newly discovered Roman villa near Brading: to say nothing of the Queen's residence at Osborne House, and numerous other lovely sites and spots.

Special facilities have been granted by the respective authorities for inspecting the Royal Victoria Hospital at Netley, the great Naval Arsenal, Dockyard, &c., at Portsmouth, and the royal yacht *Victoria and Albert*.

To the Geologist the shores of the Solent display for his investigation rocks of the greatest interest, some of which at the present time occupy the attention of men most eminent in the science. Alum Bay, Headon Hill, Colwell Bay, and Whitecliff Bay, in the Isle of Wight will be visited by means of excursions, as also probably Hardwell Cliff and Bournemouth. The Purbeck Beds can easily be reached by those who desire to pursue the subject.

Southampton is within a little more than two hours railway journey of London; and by the through communications of the railways in connection with the South Western Company, can readily be reached from any part of the United Kingdom. It also affords special facilities to those who wish to include a sea passage in their arrangements for the autumn. Steam-packets, fitted with every comfort, ply between Southampton and the ports of London, Portsmouth, Plymouth, Falmouth, Cork, Waterford, Dublin, Belfast and Glasgow; and the mail-packets of the London and South Western Railway Company maintain constant communication with Havre, Rouen, Honfleur, Trouville, Caen, Cherbourg, Granville, St. Malo, and the Channel Islands.

With reference particularly to the arrangements for the forthcoming meeting of the British Association, it may be mentioned that H.R.H. Prince Leopold, Duke of Albany, occupies the position of President of the General Local Committee, and a confident expectation is indulged that, in company with the Duchess, His Royal Highness will be present during the week. The Vice-Presidents include some two dozen of the neighbouring nobility, and resident clergy and gentry. For Chairman of the Executive Committee we have the Worshipful the Mayor of Southampton (Mr. W. H. Davis); the Vice-chairman is Mr. W. E. Darwin, M.A. (son of the late distinguished Charles Darwin); the local Treasurer is Mr. T. Blount Thomas, a former Mayor of the Town; the local Secretaries are Mr. C. W. A. Jellicoe (the Borough Treasurer), Mr. J. E. Le Feuvre (one of the Borough Magistrates), and Mr Morris Miles (an officer of long-standing on the Ordnance Survey, and President of the local Literary and Philosophical Society); whilst the Committee itself comprises about thirty of the local clergy, members of the various services and professions, &c., &c.

The President-elect is Mr. C. W. Siemens, LL.D., F.R.S., &c. The first general meeting will be held at the Skating Rink on Wednesday, August 13, at 8 p.m., when Sir John Lubbock, Bart., M.P., F.R.S., &c., will resign the chair, and the President-elect will assume his office and deliver an address. On Thursday, August 24, at 8 p.m., there will be a *soirée* in the Hartley Hall; on Friday evening, August 25, at 8.30 p.m., in the Skating Rink, a discourse on the Tides, by Sir William Thomson, LL.D., F.R.S., &c., Professor of Natural Philosophy in the University of Glasgow; on Monday evening, August 28, at 8.30 p.m., in the Skating Rink, a discourse on Pelagic Life, by H. N. Moseley, M.A., F.R.S., Professor of Anatomy and Physiology in the University of Oxford; on Tuesday evening, August 29, at 8 p.m., a second *soirée* in the Hartley Hall; on Wednesday, August 30, the concluding General Meeting will be held in the Skating Rink at 2.30 p.m. In addition to these arrangements, there will be a lecture to the operative classes in the Skating Rink on Saturday evening, August 26, by Mr. John Evans, D.C.L., V.P.R.S., &c., on "Unwritten History, and How to Read it;" and on

VOL. XXVI.—NO. 667

Sunday, the 27th inst., at the invitation of the Rector (the Rev. the Hon. Canon A. Basil O. Wilberforce), the Members of the Association, accompanied by the Mayor and Corporation, will attend Divine Service at the mother Parish Church of St. Mary, when a sermon will be preached by the Lord Bishop of Truro.

The sectional meetings will be held respectively in some one or other of the following places:—The Watts Memorial Hall, Zion Hall, the Grammar School, Portland Baptist Chapel, Kingsfield School, the Masonic Hall, the Philharmonic Hall, the County Court, the Friends' Meeting House, the Unitarian School, Taunton's Trade School, the Wesleyan School, the East Street Baptist Chapel, St. Andrew's School, &c.

The Rector has also invited the Members of the Association to a garden party in the charming Deanery Grounds on Monday, August 28, while the Southampton Yacht Club have conferred the privilege of Honorary Membership of their Club for the week on the members, &c., of the British Association; and the Hartley Council have placed the Hartley Institution entirely at the disposal of such members during their stay. The Dock Company will provide competent guides, &c., to conduct the members over the splendid series of local docks; and the Union Steam-ship Company will lend and provision their magnificent ship *Pretoria* for an all-day marine excursion (during which the boat exercise as used in case of storm, and the hose exercise as in case of fire, will be gone through), unless the vessel in question should meanwhile be required by the Government for Transport Service.

The scheme of excursions is very complete, and includes all-day excursions on Thursday, August 31, to Salisbury, Stonehenge, and Wilton Park; Portsmouth Arsenal, Dockyard, the Royal Yacht, &c.; and a marine excursion to Bournemouth, or round the Isle of Wight: as well as afternoon excursions on Saturday, August 26, to Alum Bay; Ryde, Brading, Whitecliff, Newport, and Carisbrooke; drives in the New Forest; Netley Abbey and Hospital; Romsey, Broadlands (the seat of Lord Mount-Temple), &c; Winchester and St. Cross.

The local Gas Company will give an illustration of improved gas-lighting in the Skating Rink, and from Holyrood Church to the Hartley Hall (in one direction), and to the Commercial Road (in the other); completely lighting both parts also of Portland Street, &c. The Edison Electric Light Co. will illuminate the Hartley Hall.

The various local factories (Messrs. Day, Summers, and Co., Northern Iron Works, Oswald, Mordaunt, and Co., Woolston Ship Building Works, &c.), and the yard of the Royal Mail Steam Ship Company will also be accessible to the Members and Associates with their friends.

The Mayors of Winchester, Ryde, and Newport have shown a hearty desire to co-operate with the Local Executive Committee, as have Lord Mount-Temple, and others too numerous to mention. There appears every probability that, so far as can be attained by sound, honest, local work, the forthcoming meeting will not be the least successful that the Association has held; but it must not be disguised that the Local Committee has been somewhat hampered by the financial difficulty, in which respect there is still time for those who have not subscribed to make amends by sending in their names to the Local Treasurer either as Donors, Guarantors, or both.

T. NORFOLK,
Assistant Local Secretary

THE CLIMATE OF ALEXANDRIA[1]

WE have before us seven and a half years' very full and satisfactory observations made at Alexandria, under the auspices of the Austrian Meteorological Society, from the commencement of 1875, from which a tolerably accurate account of the climate of this historically and otherwise important region of the lower Nile may be gathered. The observations have been made daily at 9 a.m., 3 p.m., and 9 p.m., and are quite continuous to the end of May last.

A marked feature of the atmospheric pressure is its comparative steadiness from year to year, attaining the annual maximum, 30·147 inches, in January, and falling to the minimum, 29·844 inches, in July, the difference being thus 0·303 inch. At Cairo the difference between the winter and summer pressures is 0·321 inch, the greater difference at Cairo being due to its lower summer pressure. The greater diminution of pressure in advancing from the Mediterranean towards the interior during the summer is an important element in the meteorology of Lower Egypt, on account of the changes of wind which result from it.

During the three winter months the direction of the wind in the morning shows a mean of 27 days for S.E., S., and S.W. winds, as against 28 days for N.W., N., and N.E. winds. On the other hand, during the three summer months, southerly winds are wholly absent, and N.W., N., and N.E. winds prevail on 79 days. Looked at broadly, northerly and southerly winds prevail in winter, northerly in summer, and northerly and easterly in spring and during October and November. The prevalence of easterly winds at these seasons is a striking peculiarity of the climatology of a large part of the Levant, and as regards the autumn, they are accompanied with a higher temperature than would otherwise be the case. During the afternoon the wind blows uniformly from some northerly point at all seasons, except in winter, when winds from the west also prevail, west winds being then 16 as against north winds 30. During the warmest months the wind is wholly from the north. The wind is also much stronger in the afternoon than in the morning. Thus the morning observations give 48 days of calms during the year, but the afternoon observations only 18; and for the seven months from May to November, there are only two days of calm, but for the same months the morning observations give 30 days of calm.

In connection with these changes of wind, the relative humidity is very interesting. The lowest humidity, 66, occurs in winter; but as the wind changes more completely into the north, the humidity rises gradually to the maximum, 76, in July, and in exact accordance therewith, whilst the daily range of temperature in winter is about 11°·0, in summer it is only half that amount. On the other hand, while the air at Alexandria approaches nearer

---

[1] "Meteorologische Beobachtungen an sechszehn Stationen in Österreich und drei Stationen (Alexandrien, Beirut und Sulina) im Ausland. (Wien, 1875-82.)

towards saturation in summer, the sky at the same time becomes more completely cleared of clouds than in winter. Thus the mean cloudiness in winter indicates that four-tenths of the sky is covered, but in summer there is only one-tenth. This increased relative humidity, occurring simultaneously with increased clearness of sky, is an important feature of the climate of Alexandria, being productive of a heat in the direct rays of the sun much less intense than the clearness of the sky and the latitude might lead us to expect.

The mean annual temperature is 68°·7, the minimum being 57°·6 in January, and the maximum 78°·9 in August. The coldest January, 54°·0, occurred in 1880, and the warmest, 62°·1, in the following year, there being thus 8°·1 of a difference. No such difference occurred in the summer months. Thus the coolest August was 77°·7 in 1876, and the hottest, 80°·2 in 1880, the difference being only 2°·5. At Cairo the differences of temperature are much greater. The daily range is considerably greater than that of Alexandria; the mean temperature of January is 54°·1, and of August 84°·5, and as regards variation of the monthly temperatures from year to year, the mean of January was 50°·0 in 1880, but 59°·2 in 1881; and the mean of August was 80°·6 in 1876, but 90°·7 in 1877, the daily range for the two seasons being thus 9°·2 and 10°·1.

At Alexandria the mean annual rainfall is 8·12 inches, falling on 44 days. The largest annual fall was 10·75 inches in 1876, and the least 3·42 inches in 1879. The following are the means in inches for the months:—January 1·95, February 1·46, March 0·72, April 0·15, May and September 0·02 each, June, July, and August *nil*, October 0·58, November 1·52, and December 1·70. Heavy rainfalls are of occasional occurrence. During these seven and a half years the fall for one day exceeded an inch on 13 occasions. The largest of these falls 3·00 inches, occurred on October 7, 1876. Hail has been recorded on nine separate days in all, and thunder and lightning on eight days.

The following peculiarity in the annual march of the temperature is noteworthy. The mean temperature of June is 75°·0, July 77°·5, August 78°·9, September 77°·7, and October 74°·4, from which it is seen that September is warmer than July, and October nearly as warm as June. This peculiarity is still more striking if we look exclusively at the daily maximum temperatures which are so important an element of climate. To show this, we subjoin the means and extremes of the daily maxima, week by week, from July 1 to October 27:—

1876-81.	Means.	Highest observed.
July 1-7	80°·3	86°·2
,, 8-14	80·6	84·0
,, 15-21	81·6	86·2
,, 22-28	81·7	88·0
July 29-Aug. 4	81·8	86·5
Aug. 5-11	81·9	87·1
,, 12-18	82·2	86·5
,, 19-25	83·8	97·2
Aug. 26-Sept. 1	83·4	90·1
Sept. 2-8	83·4	95·0
,, 9-15	83·4	93·9
,, 16-22	82·4	88·0
,, 23-29	83·3	97·9
Sept. 30-Oct. 6	83·4	97·9
Oct. 7-13	82·1	103·1
,, 14-20	79·7	87·4
,, 21-27	79·3	84·0

Thus, then, we see that the highest temperatures during the year have taken place in the end of September and the first half of October, and that absolutely the highest temperature yet recorded, 103°·1, was on October 11, 1877; and that while the highest weekly mean occurred in the latter half of August, a secondary maximum, nearly as high, occurred in the beginning of October. It will be also observed that up to the close of October, the temperature is still nearly as high as in the beginning of July, but after this date temperature rapidly declines. That this is no chance result peculiar to the years of observation is shown by the recurrence of this feature of the climate year by year, as well as by the temperature of Jerusalem and other places in the East.

Practically, from May to September inclusive, no rain falls. The precise date of the commencement of rain greatly differs in different years. The following are the dates for each of the seven years, marking the earliest day on which at least one-tenth of an inch of rain fell, which may be considered as marking roughly the termination of the dry season at Alexandria: 0·18 inch on November 4, 1875; 3·00 inches on October 7, 1876; 0·22 inch on October 16, 1877; 0·93 inch on November 29, 1878; 0·27 inch on December 20, 1879; 0·15 inch on September 27, 1880; from which date the rainfall was all but *nil*, till 0·14 inch fell on November 27, and 0·32 inch on November 15, 1881. Leaving out of view the small sporadic fall in September, 1880, the earliest date for the termination of the summer drought was October 7, and the latest December 20, the mean date of the seven years being November 12.

On advancing from the Mediterranean sea-board into the interior, the climate rapidly changes; the rainfall becomes less and less, and then practically ceases; the air becomes drier, and the sky clearer; the sun's heat stronger, the nights cooler, and the daily range of temperature greater. At Cairo the rainfall is quite insignificant in amount, but occasionally pretty heavy falls occur. Thus on January 10, 1870, 1·02 inch fell, and on May 3 of the same year 0·67 inch. From January to May of the present year 1·16 inch has fallen, of which 0·80 inch fell during the six hours ending 7 P.M. of April 1. The temperature rose at Cairo to 112°·6 on June 5, 1872; to 113°·2 on May 25, 1873; and to 116°·4 on May 20, 1869, the highest recorded at Alexandria being as stated above, 103°·1. During September and October, the mean temperature of the two places is nearly the same, with, however, this essential difference, which must not be lost sight of; the days are much hotter and the nights much colder at Cairo, where consequently greater precaution must be taken against chills at night, these being the fruitful source of diarrhœa, and other complaints which often prove so disastrous during campaigns carried on in such climates as that of Egypt.

COLLIERY VENTILATION

The Principles of Colliery Ventilation. By Alan Bagot, Assoc.M.Inst.C.E., &c. (London: Kegan Paul, Trench, and Co., 1882.)

DURING the last ten years, or, ever since it has become necessary for colliery managers to obtain certificates of competency by examination, there has been a ready sale for books like the one before us, which treat of a few mining subjects in an elementary manner, and more especially of ventilation, and the chemical and physical properties of the gases that are commonly found in mines. Mr. Bagot has evidently taken considerable pains in amassing his information from various sources, some of them original; and, if we could only add that he appears to have exercised the same degree of care in placing it before the reader, in a concise and orderly form, we would have little else besides commendation to bestow upon his volume. As it is, however, we regret to observe that the whole book is written in a somewhat discursive and disjointed manner. It contains an impossible geological section on p. 109; and nearly every one of its chapters teems with rules and advice for the guidance of all sorts of colliery officials from the engineer to the collier. We had hitherto imagined that the General and Special Rules of the Coal Mines' Regulation Act were already wellnigh as complete as our knowledge and experience could make them up to the present time, and we think, therefore, that Mr. Bagot might, without impropriety, have appended to his work copies of those parts of both which have a direct bearing upon his subject, selecting his examples of Special Rules from amongst those which most meet with his approval. Instead of pursuing such a simple and commendable course, however, he chooses rather to give us his own ideas of what these rules ought to have been; he endeavours to supply what he considers to be omissions, and he makes many statements of a purely dogmatical character which could not bear the touch of close and careful reasoning. Let us take what he says about the duties of a *fireman*, at p. 73, as an example:—

"The fireman's duties are very hazardous. He is a *competent person solely employed to test the pit for gas.* When inflammable gas has been found (and we presume that all viewers will see the propriety of examining before each shift begins work, even where it has not been found) he has to examine the pit once in every shift, or once in every twenty-four hours; should he find gas, he must report the same in a book kept for the purpose. The Act should have made him post a notice at the pit-head containing extracts from the book, showing briefly where gas had been found throughout the mine. He also places 'fire-boards,' or notices of dangerous gas, at the entrance to headings which have been found in his examination to contain it. These boards should be painted red and made easily recognisable to miners who cannot read. Another most responsible duty of the fireman is to act as the 'competent person' where shots are being fired. No shots should be fired where naked lights are used in the vicinity, as a large volume of gas may exude or be discharged after the shot and so become ignited, although the ventilation may be ample; neither should lamps on Davy's principle be used for the operation, but self-extinguishing lamps, such as Stephenson's or Williamson's safety lamps."

The advisability, or otherwise, of substituting self-extinguishing safety lamps for those now commonly used is a question that has agitated the mining community on many occasions before now. Our author, however, seems to regard it as almost a question of his own raising, and as he takes it up with such zeal and pursues it with so much avidity, we propose to devote a few words to its discussion. In the preface we find him saying:—

"Her Majesty's Commissioners appointed to inquire into mining accidents in their 1881 Parliamentary Report draw attention to this risk"—the risk attending the use of Davy and Clanny lamps—"but I think that this report will be but little heeded judging from experience, inasmuch as, on April 25, 1879, I read a paper before the Institution of Mechanical Engineers on the subject, with experiments proving the defects in Davy's lamp and many other modified forms of it in use in mines; and in a work of mine published in 1878, I state the fact that the Davy lamp will explode in an explosive mixture travelling at a velocity of eight feet per second." . . . "If the Government will not be convinced of the folly of sanctioning the use of Davy, Clanny, and all non-extinguishing safety-lamps in mines, the only chance to avoid these disastrous explosions is to appeal to the common sense of mining engineers."

And again—passing over other intermediate references—at page 148:—

"I have continually pointed out the danger of using non-extinguishing lamps in fiery mines, and at last the attention of the Government has been called to the danger by the Commissioners, but great blame attaches, to my mind (*sic*) that this fact was ignored so long."

It seems to us to be both unjust and unfair on the part of our author to bait the Government after this fashion, inasmuch as it was already in possession of a vast mass of information concerning this formerly much-discussed question, long before he began to write about it. Davy himself knew and pointed out the defect of his lamp nearly seventy years ago. Dr. Pereira made experiments to illustrate the same thing for the information of the Select Committee on Accidents in Mines, which sat in 1835. In their Report, that Committee made most urgent representations on the subject to the Government of their day. At the same time a strong effort was made to introduce Upton and Robert's self-extinguishing safety-lamp, which now exists only as a historical curiosity amongst others of the same kind in the Jermyn Street Museum. In 1850 or 1851 the late Mr. Nicholas Wood revived the question, and made the first experiments we know of, which fixed the velocity at which the explosive air must be travelling before the flame will pass through the wire gauze. From that date until the time of his death, thirteen or fourteen years later, he continued to advocate the adoption of self-extinguishing safety-lamps, choosing Stephenson's for his model. About the year 1866 the North of England Institute of Mining Engineers appointed a Committee to consider the matter. They conducted a splendid series of experiments which literally exhausted the subject, and they published the results in their Transactions. About the same time the Government of Belgium appointed a Commission for the same purpose, who, after continuing experiments intermittently over a period of ten years, made a short report to the King, and the result was the immediate promulgation of a law making the use of Mueseler self-extinguishing safety-lamps compulsory in the mines of that country. Finally we might cite the experiences in France, the reports published under the authority of the Commission du Grisou, which has just brought its labours to a close, the interrogatories addressed by the same authority to the principal mining districts of France, the opinions expressed by the various engineers, the discussions which took place, the conclusions, and the official replies.

Having all these facts before its eyes, and remembering that, according to their own showing, the Commissioners on Accidents have stated nothing that has not been well-known for many years, the Government could not very well be "convinced of the folly of sanctioning the use of Davy, Clanny, and all non-extinguishing lamps in mines," unless it is favoured with some new reasons for doing so in addition to those that have failed to convince so many generations of its predecessors. The Government could not very well retain its dignity, and at the same time shift its ground at the instance of every comer who thinks he possesses the long-sought-for panacea; but there are some eager spirits in our midst who appear to be for ever bent upon goading it into a hare-like speed, forgetful, evidently, of the moral of the fable which gives the final victory to the more slowly travelling tortoise.

We have only one more remark to make, and then we must conclude this already too long notice, namely, that a book which is written ostensibly for the education and information of even a section of the community ought not to contain recommendations of different kinds of apparatus which are apparently made and sold for the pecuniary benefit of the author. Mr. Bagot can have plenty of opportunities for advertising his improved and patented appliances without scattering notices of them through the pages of his books; and we would fain hope and believe that he was unaware of the gravity of his fault at the time he was in the act of committing it in the present instance.

WILLIAM GALLOWAY

OUR BOOK SHELF

Theogonie und Astronomie. By A. Krichenbauer. (Vienna: Carl Konegen, 1881.)

DR. KRICHENBAUER believes that he has discovered a new key to ancient mythology. With the help of the Iliad and Odyssey, the gods of Greece are resolved into stars and constellations, and the facts of astronomy are made to explain their nature and attributes, as well as the myths that were told of them. In the deities of Egypt, of Babylonia, of India, and of Iran, Dr. Krichenbauer finds fresh confirmations of his views. The development of this early astronomical theogony falls into two periods, the first period being one of creation and growth, the second of fixity and nationalisation. The first period has its "climacteric" in B.C. 2110, when the Ram already ushered in the year. But its real history belongs to that earlier age when the Bull took the place of the Ram, and it is the Bull, accordingly, which stands at the head of the religious system, and breaks in sunder the egg of the universe. The second period begins with the change of the summer solstice from the Lion to the Crab in consequence of the precession of the equinoxes, and thus falls about 1462 B.C., when the commencement of the year was transferred from the summer solstice to the vernal equinox. The equal division of the path of the sun into the twelve signs of the Zodiac took place about seven centuries later. This, briefly put, is the substance of Dr. Krichenbauer's work. His interpretation, however, of the passages of Homer upon which his theory is based, is purely subjective, and is not likely to commend itself to others. Homeric scholars, at any rate, will not admit that any portion of the Iliad or Odyssey is anything like so old as he would make them, or can contain traditions of anything like so old a period. His acquaintance, again, with the facts that modern research has recovered from the monuments of Egypt and Babylonia, is of the most meagre kind. Hence he is quite unaware that we happen to know a good deal about ancient Babylonian astronomy, and the history of the Zodiacal signs, as has lately been pointed out in NATURE, and that what we know is altogether inconsistent with his statements and conclusions. Thus the year began with the vernal equinox, and the heaven was divided into twelve equal portions at least as early as B.C. 2000, and probably much earlier, while it was in Babylonia that the constellations and Zodiacal signs were first named. On the other hand, there was not the remotest connection between the theology and mythology of Babylonia and Egypt. Before Dr. Krichenbauer again writes on this subject it would be advisable for him to be better acquainted with the results of modern Oriental research.

Atlantis: the Antediluvian World. By Ignatius Donnelly. (London: Sampson Low, Marston and Co. 1882).

OUR only reason for noticing this curious book is that the names of writers of authority which constantly appear in its pages may lead some readers astray. But the author, while quoting them, has neither assimilated their method nor understood the bearing of their facts. In spite of the patient labour bestowed upon the work, and the numerous illustrations with which it is adorned, it is merely another contribution to that mass of paradoxical literature which awaits the "Budget" of a second De Morgan.

The Early History of the Mediterranean Populations, &c., in their Migrations and Settlements. By Hyde Clarke. (London: Trübner and Co., 1882.)

DR. HYDE CLARKE has compared together the devices found on the coins and gems of various ancient cities and countries, in the hope of proving the connection of the populations to which they belonged. The list is a useful one, though defective, but it proves no more than that in a very late period of the history of the Mediterranean peoples certain obvious objects were selected in different places alike as emblems and devices upon coins.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Speechless Man

IN his notice of my work on "Asia," in last week's issue of NATURE, Mr. Sayce finds fault with me for rejecting the modern doctrine that "man was speechless when the leading races were differentiated from one another." I certainly do reject that doctrine, but not on the ground that he supposes. I reject it as in itself to the last degree improbable, and as utterly inadequate to account for the conditions which have suggested it. Seeing that there are many more radical forms of speech in the world than there are radical physical types, if indeed any of the physical types can be regarded as radical, anthropologists have somewhat rashly concluded that these forms of speech must have sprung up independently of each other after the dispersion of an assumed speechless human race throughout the world. We are in fact asked to believe that the continents were first peopled, here by a black, there by a white, elsewhere by a yellow, a brown, or a red species, all possibly sprung of one stock, but all still ignorant of any except perhaps a sign-language at the time of the dispersion. Then there came a time or times when these diverse species began all of them to babble independently of each other in their diverse independent settlements. Consequently, while the races may have been originally one, the stock languages had each a separate starting-point, and therefore were never originally one. Hence this sufficiently violent assumption is made in order to explain the present diversity of speech on the globe. I, on the contrary, hold that it is a useless assumption, that it explains nothing, that it is an all but incredible hypothesis, and lastly that the present diversity of speech on the globe admits of another, a much more simple and rational explanation.

What are the facts? Col. Garrick Mallery has an interesting paper also in last week's NATURE, on Gesture Speech, in which he tells us that there are, or were, in the United States alone sixty-five stock languages differing from each other "as radically as each differed from the Hebrew, Chinese, or English." And how many more in Mexico, Central, and South America? In Europe we have at least one still surviving, the Basque. In Asia there are at least thirty-five or forty. But who will count the number in the Sudan, and in the Oceanic regions occupied by the Negrito, Papuan, and Melanesian tribes? It is no exaggeration to say that probably as many as two thousand of these stock languages have been evolved since man first began to utter articulate sounds.

Now if it be necessary to postulate two independent evolutions of human speech in order to account for two independent forms of speech, it follows that we must postulate two thousand independent evolutions of human speech in order to account for these two thousand independent forms of speech. Are the advocates of speechless races prepared to go this length? Or do anthropologists at all realise the nature of the problem, when they propose to explain the existence of fundamentally distinct languages by the assumption of a corresponding number of independent centres of linguistic evolution? If they draw the line short of one or two thousand such centres, how do they propose to meet the difficulty presented by so many separate types of speech? Frederic Müller left the problem just where it was when he arbitrarily fixed the number of physical and linguistic families at twelve.

But so marvellous is the evolution of speech, that one may well doubt whether it occurred even so many as twelve times ever since the appearance of man on the earth. For my part I decline to believe that it occurred more than once, if once be sufficient to account for the present conditions. And it is on this ground that I take my stand. Anything short of, say, two thousand evolutions of speech are inadequate; one suffices! Under like conditions speech becomes differentiated far more rapidly than physical features. The former is essentially more or less evanescent; the latter are relatively persistent. Hence during the many ages of man's life on the globe, his physical type has been but slightly modified, producing mere varieties—a black and woolly-haired, a yellow and lank-haired, a fair and wavy-haired variety, and so on. But the primeval linguistic type or germ has become differentiated into varieties, species and even genera, whence the various morphological orders of speech, four in number, and the many now fundamentally distinct groups and families developed within each of those morphological orders, some extinct, some dying out, some still flourishing. The germ itself, which served as the common starting point, but which was itself at first little more than speech "in petto," has long been effaced past all recovery. Hence, although starting from one common centre, it does not follow that the linguistic families now existing can ever again be traced back to that common centre. Aided as we are by embryology and the fossil world, can we trace back the various orders of plants and animals to their common centres? Yet no evolutionist doubts that they were differentiated from such centres. But language, although it may be said to have a sort of embryology within itself, revealing the growth of its inner structure, leaves no fossils behind it. Its "missing links" are lost for ever. Hence it is not surprising that, in dealing with the evolution of speech, much more must be postulated than is always necessary in dealing with the evolution of organised life. It follows that while Darwinism as applied to organisms may one day be established scientifically, Darwinism as applied to language, must always partake somewhat of the nature of a hypothesis. Meanwhile I submit that, on the reasons here given, the hypothesis of a common primeval linguistic germ is both rational and adequate, whereas the hypothesis of speechless races is both improbable in itself, and fails to account for the very conditions to explain which it has been invented.

A. H. KEANE

The Chemistry of the Planté and Faure Batteries

IN your issue of the 20th ult. there is a letter by Dr. Oliver Lodge on the recent experiments of Mr. Tribe and myself. While confirming our general results from his own experience, he asks a question about the lead sulphate into which we state the spongy lead is converted during the discharge of a Planté or Faure battery.

In an early stage of our investigation we satisfied ourselves that lead sulphate was capable of both oxidation and reduction by the voltaic current, under the circumstances found in these batteries. Our best experiment is described in NATURE of March 16. It was made by spreading lead sulphate on platinum plates; but I have just had it repeated with lead plates, so as to imitate more closely the conditions of actual practice. The sulphate was reduced by the electrolytic hydrogen as before. As, however, the reduction takes place first in close proximity to the lead plate, it is not easily recognised till the chemical change has advanced some distance, and a good deal of the white salt always escaped decomposition. But the circumstances of the actual practice are much more favourable for the reduction of the sulphate than were those of our experiment: for the sulphate is formed in perfect contact with the metallic lead of the plate or its spongy covering, and the reduction is doubtless facilitated by its intimate mixture with the excess of spongy lead. When we stated that sulphate of lead is finally the "only product of the discharge," we were referring to the disappearance of any peroxide, and did not mean to imply that in actual practice the whole of the spongy metal is usually converted into sulphate.

In our experiments Mr. Tribe and I have always employed a sufficiency of acid, and we have never found any difficulty in charging again a plate which had been discharged.

In conclusion, I may express my great satisfaction that Dr. Lodge is carrying on an independent inquiry into the obscure chemical changes that take place in these cells.

Bowness, August 5 J. H. GLADSTONE

The Late Prof. Balfour

PERMIT me to add a few words to Dr. Foster's admirable biographical sketch in the last number of NATURE, and thereby correct a slight error into which he has fallen. He assigns to me the credit of inviting our much-lamented friend to give lectures on animal morphology. It behoves me to say that I have no claim to so much foresight. The proposal, so characteristic of Prof. Balfour's ardent disposition, originated, to the best of my belief, with him, and all I had to do was to place at his service, with the consent of the Vice-Chancellor for the time being, my private room in the New Museums, which I was glad to see turned to so good a purpose, for hitherto but little use had been made of it. The result is sufficiently well known.

ALFRED NEWTON

44, Davies Street, London, August 5

M. Raoul Pictet's Corpuscular Theory of Gravitation

I BELIEVE that I can remove M. Pictet's uncertainties regarding the credibility of the presumptive origin of attractive force in the undirected motion of an all-pervading material ether, without adopting the desponding alternative to which he appears to be obliged (in perhaps needless extremities) to betake himself, that it might be conceded "without its being possible to explain it." My reasons for accepting the proposition without any doubt or question, would at least, I believe, if they could be submitted to him in a form of faultless coherence and completeness, relieve him from pursuing the laborious purpose, which I am perfectly assured from my own apprehension of the real character of the equivalence, and of the mode of establishment which it admits of, would fail in its intended object, of undertaking a series of pendulum experiments to prove it.

Before reading the translation in NATURE, vol. xxvi. p. 310, of M. Pictet's paper on a comparison between the potential and corpuscular theories of attractive force, I had in fact just assured myself satisfactorily of the correctness of exactly the conclusion of which he has given such a clear and distinct enunciation, from a theory of thermodynamic actions which proceeds upon an entirely different basis from that which he has skilfully, and in so many cases successfully, applied. The demonstration which I used is a sufficiently clear and consistent one to be convincing; but it is founded upon a chain of reasoning which is quite independent of that employed by M. Pictet, and it does not actually lead me to entertain the theoretical conclusion that the apparent force of gravitation on a planet will be in any measure directly dependent on, and variable with the varying velocities of other planets' motions in the solar system; but that it will be a constant effect of the ethereal medium. If therefore the proof which I could offer of his proposition deserves to be regarded as a valid one, it will not only avoid the necessity of any more experimental evidence than we already possess of the nature of gravitative action, but it will also afford at the same time a satisfactory confirmation of the kind of ethereal explanation of gravitation of which M. Pictet is in search.

I have been delayed hitherto in publishing my views of the primary character of thermo-dynamical principles by difficulties which at the outset attended their applications to explain the experimental phenomena of conduction and radiation. These difficulties, however, and others naturally incident to the development of a new physical conception, I believe that I have satisfactorily mastered and overcome. But I anticipate the needs of much greater expansions in the theory before it will avail as completely as in those important cases, to include and demonstrate properties of specific and latent heats, and of dilatation, and the other thermal phenomena of fusion and evaporation, and of vapour tension, to which M. Pictet has found for his theory such useful applications.

Taking his departure from an entirely different common principle of thermal actions from that with which I set out, the results of M. Pictet's researches will yet, I believe, accord intimately, wherever the two parallel methods have a common meeting-point, with my own deductions. I accordingly entertain great hopes of recognising among his examples of conformity to a common law and method, links and steps of demonstration in a complete theory of the properties of heat, in phases of its action where physical axioms not exactly akin to his own fail to furnish me with sufficient explanations of them; in the same way that it has afforded me great pleasure to offer full corroboration of M. Pictet's views, from my own inquiries, at a point where his theoretical hypotheses have proved insufficient to cope with an exceedingly extensive and general provision of kinetic laws, much more comprehensive in its physical relations than those mechanical deportments of which we observe the properties and laws in ponderable matter, when it is not under the more profoundly modifying and affecting influence of the all-energising power and all-pervading agency of heat.

Collingwood, Hawkhurst, July 29 A. S. HERSCHEL

M. Cailletet's Pump for Condensing Gas

AT page 308 of your last number you mention a pump invented by M. Cailletet for condensing gases, in which he uses mercury as a fluid piston, in order to fill every interstice of the pump barrel, and so expel the last atom of gas; of course, in this case, he would use an ordinary plunger pump, with both the inlet and outlet valves at the top, and the proper quantity of mercury in the barrel, so as to fill it completely in the downstroke of the plunger or piston.

It is curious that a similar pump is figured in the first volume of the *Mechanics Magazine*, 1823, page 232, as invented by Henry Russell; and I have always understood that a modification of this was used by David Gordon at the unfortunate "Portable Oil Gas Co.", to condense gas into the reservoir from which his lamps were filled. The patents are Gordon and Heard, 4391—1819, and David Gordon, 4940—1824; a company was formed at the time for using his lamps, and was worked for a few years, but the *royalties* having much exceeded the *profits*, the Company came to grief. ROBT. J. LECKY

3, Lorton Terrace, Notting Hill, August 2

Spectrum of the Light of the Glowworm

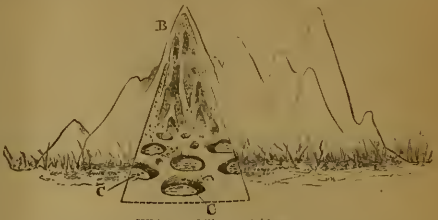
WHEN the subject of the phosphorescence of the Lampyridæ came under discussion at the meeting of the Entomological Society of London on February 4, 1880 (*Proc.* Ent. Soc., 1880, p. iii.) Mr. Meldola stated that "Some years ago he had examined the spectrum of the glowworm, and found that it was continuous, being rich in blue and green rays, and comparatively poor in red and yellow." This substantially confirms the observation of Sir John Conroy, although Mr. Meldola gives no measurements. JOHN SPILLER

Canonbury, August 5

White Ants' Nests

I OBSERVE in NATURE, vol. xxvi. p. 72, from line 13 to 35 inclusive, some remarks regarding the composition of the inner of the two distinct structures composing an ant hill, and that though the composition of the inner parts was chemically the same as wood, it was structureless, and its origin not known or understood.

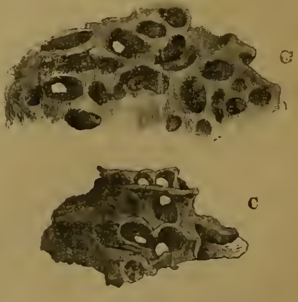
I believe it is simply composed of the *excreted* refuse of the wood on which they feed, and formed into sub-spherical combs in which the young are generally found. The walls of the ant hill are of pure clay perforated with passages; towards the centre there are large chambers in which these combs are constructed, and they are full of passages and small chambers, the walls about 1-20th of an inch thick. I send some rough sketches that may serve to illustrate these, in case they may be worth insertion.



White ant-hill, part laid open.

B —Part of clay walling, full of passages.

It is no wonder these combs are structureless and yet of the same chemical composition as wood. If a box full of papers or books is attacked the results are only too well known to those living in the tropics.



C —Part of a comb, full of chambers

Asam, June 18 S. E. PEAL

Voice in Lizards

I HAVE been much surprised to see by the recent letters in NATURE that there was any doubt as to the lizard having a voice. I have so often heard and seen a lizard uttering its peculiar notes, that I did not imagine there was anything unusual in the circumstance. The voice is a shrill "chirp," and the whole body and tail vibrate simultaneously with its utterance.

Madras, July 9 Surgeon

Halo

With reference to the very interesting remarks which Prof. Silvanus Thompson makes in this week's Nature on the "halo" observed by me on the 16th as appearing over Dalkey Hill, I ask leave to give the correct bearing of the direction in which it was seen, L. 35° S. I may further remark that I never have seen anything similar in this country, though I had continuous occasions of observing halos in the Bay of Biscay from the coast. They seemed to be connected with dominating easterly winds there.

The weather during the week has been rainy and the temperature low for the season. J. P. O'Reilly

Royal College of Science for Ireland, Dublin, July 28

OUR ASTRONOMICAL COLUMN

The Spectrum of Wells' Comet.—Dr. B. Hasselberg, of the Observatory of Pulkowa, in a letter to Prof. Tacchini, dated June 30, describes his spectroscopic examination of this comet, the results of which he shows to be of a very exceptional character. The observations were made on the nights of June 4, 5, and 7. The brightness of the nights at Pulkowa in the summer had influenced unfavourably his spectroscopic observations of the great comet of 1881, and the position of Well's Comet was also a disadvantage, so that he had not expected a prominent spectrum, and the more because observations by Prof. Tacchini and Dr. Vogel at the commencement of April did not promise much. His surprise was therefore the greater on finding a very bright and extended continuous spectrum of the nucleus, with an excessively strong yellow line, of which the micrometrical measures proved the perfect identity with the yellow line of sodium, line D of the solar spectrum. This was a result altogether new in cometary spectroscopy, and the more noteworthy because at the same time there were no traces of the three ordinary bands of the spectrum. It is confirmed by Dunér, Bredichin, and Vogel. In the middle of May, on the contrary, Vogel's observations show that the three bands were then present, though faint, while of the sodium line there was not the least trace. It is therefore necessary to conclude that during the last fortnight of this month the spectrum of the comet had changed in a manner of which the history of the science furnishes no precedent. Dr. Hasselberg then explains his views of the *modus operandi* of these changes, and concludes:—"Je crois, donc, que dans le cas actuel, la chaleur solaire n'a joué autre rôle que de faire évaporer le sodium contenu dans la comète, et que les phénomènes lumineux et spectraux observés ont été provoqués et entretenus principalement par des décharges électriques mises en jeu sous l'influence du soleil."

This comet is again under observation in Europe. Prof. Julius Schmidt observed it at Athens as early as July 4; he gives his daylight observations in detail in No. 2447 of the *Astron. Nach.*, but the excellent meridian observations made at Albany, U.S., render them of less importance than might otherwise have attached to them.

Occultation of a Star by Jupiter.—The star 4 Geminorum, which has usually been considered a seventh magnitude, but is 7·4 in the *Durchmusterung*, will be occulted by the planet Jupiter, on the morning of November 8, the phenomenon being favourably observable at the observatories of the United States. The apparent place of the star at the time, according to the "Greenwich Catalogue" for 1864, is in R.A. 6h. 3m. 25s.·59, Decl. + 23° 0′ 57″·8, and at conjunction in R.A. Nov. 7, 14h. 12m., Washington M.T. it will be 5″ south of the centre of the planet according to Leverrier's position. Assuming the accuracy of the places, the immersion may be observed in this country.

Nova Ophiuchi, 1848.—Prof. Holder obligingly writes from the Washburn Observatory, University of Wisconsin, on July 22:—"In your note of May 4, 1882, you ask for an estimate of the magnitude of the *Nova* of 1848, whose position is (for 1880·0) R.A. 16h. 52m. 47s. N.P.D. 102° 42′. I looked for this object on July 18, and found it by help of your allineations with three stars which I had copied in my observing list, but I had, however, no note of its magnitude. There are three faint stars near it.—

1. Mag. 13 in p = 25°±
2. ,, 13·5 in p = 160°±
3. ,, 14 in p = 270°±

The *Nova* itself is between 12·5 and 3·0 mag. according to my estimate, and has no colour.

This estimate proves that no very sensible change has taken place since 1875.

Schroeter's Observations of Mars.—Prof. Bakhuysen announces the publication of Schroeter's "Areographische Beiträge zur genauern Kenntniss und Beurtheilung des Planeten Mars," a work which he had designed to publish himself, and had nearly completed at the time of his death, in 1816. The manuscripts and copper plates were in the possession of H. Schroeter, of Linsburg, near Nienburg on the Weser, a grandson of the astronomer, and Prof. Bakhuysen having heard, through Dr. Terby, of Louvain, in December, 1874, that he had some intention of disposing of them to a scientific institution, took measures to obtain them for the Observatory at Leyden; the authorities in that University favourably received the application made to them, and provided the necessary funds for the purchase, and early in 1876 the Observatory was in possession of the manuscripts of the "Areographischen Beiträge," with fourteen copper plates belonging thereto. The publication has been undertaken by the firm of E. J. Brill, of Leyden. Two-thirds of the work appear to have been twice revised by Schroeter himself, so that the greater part of it is issued in the state which it was designed that it should be by the author. Prof. Bakhuysen mentions in his "Prospectus" that he had newly reduced Schroeter's observations for the position of the axis of Mars, and found its longitude and latitude 352° 59′ and 60° 32′, which is in nearer agreement with Oudemann's reduction of Bessel's few measures than with the recent determination of Schiaparelli.

KOREAN ETHNOLOGY

At a recent interview with Mr. Charles Marvin, M. Semenoff, vice-president of the Russian Geographical Society, remarked that "every annexation in Central Asia is a source of satisfaction to our scientific men. Fresh fields are opened up for research, and all this must naturally be of interest to persons devoted to science." Some such thoughts will probably have occurred to most ethnologists on hearing that Korea has at last broken through the barriers of exclusiveness and concluded commercial treaties both with England and the United States. Foreigners will doubtless for some time be restricted to the three treaty ports thrown open on the eastern and southern coasts, and to Seul, the capital, where British and American political agents will reside. But the opportunities thus afforded of studying the interesting inhabitants of this region cannot fail to be gradually extended, until the whole peninsula becomes accessible to scientific exploration. Meantime a few notes on the ethnical relations of the people to their neighbours will probably be acceptable to the readers of Nature.

The term *Korea*, now applied to the whole peninsula, was originally restricted to the northern state of *Korié*, the Chinese and Japanese forms of which were *Kaoli* and *Korai* respectively. With the fusion of Korié, Petsi, San-kan, Kudara, and all the other petty states into the present monarchy about the end of the fourteenth century, the name of the northern and most important of these principalities was extended by Japanese writers to the whole country, while the monarchy itself, at that time subject to China, took the official Chinese title of Chaosien (Tsiosen), or "Serenity of the Morning," in reference to its geographical position between the continent and Japan, the "Land of the Rising Sun." For the inhabitants themselves there seems to have been no recognised general name, although those of the southern division were commonly designated in Japanese history by the expression *Kmaso*, or "Herd of Bears," yet to the people thus contemptuously spoken of, the natives of the archipelago were indebted for a knowledge of phonetic writing, for their peculiar Buddhism, for their porcelain and some other industries. Political relations had been established between the two countries certainly before the third century of the new era, when a large portion of the Peninsula was reduced by the Queen Regent Zingu. Since then the political ascendency has oscillated between China and Japan, and the substantial independence hitherto preserved by the Seul government must be mainly attributed to the rivalry of its powerful neighbours.

The Korean race is commonly regarded as a branch of the Mongolic stock. But it really seems to have resulted from the fusion of two distinct elements, the Mongolic and Caucasic, the former no doubt predominating. These are probably the Sien-pi and San-han of Chinese writers, from whose union the present inhabitants are said to have sprung. The San-han (San-kan, or "Three Kan") prevailed in the central parts, and were apparently Mongols, while the Sien-pi, numerous especially in the south, are, perhaps, the above-mentioned Kmaso of the Japanese historians, representing the fair type, whose presence is attested by overwhelming evidence.[1] These Kmaso made frequent predatory excursions in very ancient times to Kiusiu and Hondo, even forming permanent settlements on several parts of the coast. It is probable that they also reached the Riu-kiu (Lu-Chu) archipelago, and thus may the presence be explained of a certain fair element in Japan itself, and especially in the Riu-kiu group.

The Caucasic seem to have preceded the Mongol tribes in the peninsula. But they were gradually out-numbered and largely absorbed by the yellow stock, owing to constant migrations, especially from the Chinese provinces of Pechili and Shantung, throughout the fourth and fifth centuries of the vulgar era. It is also to be noted, that with every revolution or change of dynasty in China, the leaders of the defeated party usually took refuge with their followers in Korea. The Mongol stock was thus continually fortified, while the stream of Caucasic migration had ceased to flow from prehistoric times. Hence it is not surprising to find that the prevailing type is now distinctly Mongoloid. Of the nine or ten million inhabitants of the peninsula, probably five-sixths may be described as distinguished by broad and rather flat features, high cheek-bones, slightly oblique black eyes, small nose, thick lips, black and lank hair, sparse beard, yellowish or coppery complexion. The rest, representing the original Caucasic element, are characterised by rounded or oval features, large nose, light complexion, delicate skin, chestnut or brown hair, blue eyes, full beard. Between the two extremes there naturally occur several intermediate shades, all of which serve to explain the contradictory accounts of the missionaries and travellers speaking from actual observation, but generally ignorant of the original constituent elements and ethnical relations of the natives. All, however, agree in describing them as taller and more robust than the Chinese and Japanese, while fully equal to them in intelligence and moral qualities. They are a simple, honest, good-natured people, very frank, laborious, and hospitable, although hitherto compelled by their exclusive laws to treat strangers with suspicion and an outward show of unfriendliness. That this unfriendliness is merely assumed through fear of the authorities is abundantly evident from Capt. Basil Hall's account of his intercourse with the natives of the islands on the west coast.

Polygamy, although permitted, is little practised, in this respect resembling their peculiar Buddhism. But while some consideration is shown for the women, to whom the streets are given up in the evening, the gods are treated with the greatest contempt and indifference. In many towns there are no temples, nor even any domestic shrines. The images of gods and saints are mere wooden blocks set up like landmarks by the wayside, and inferior as works of art to the idols of the Polynesians. When one of these divinities gets blown down or rots away, it becomes the sport of the children, who amuse themselves by kicking it about amid the jeers and laughter of their elders. The religious sentiment, which may be said to culminate on the Tibetan plateau, seems to fade away west and east as it descends towards the Atlantic and Pacific seaboards.

Formerly masters of the Japanese in many arts, the Koreans at present cultivate few industries beyond the weaving and dyeing of linens and cottons, and the preparation of paper from the pulp of the *Brussonetia papyrifera*. Silks and tea are imported from China and Japan, and the exports to those countries have hitherto been mainly restricted to rice, raw silk, peltries, paper, tobacco, and ginseng.

But for the Chinese influences, which are of comparatively recent date, the speech of the Koreans would betray few indications of their mixed origin. Here as elsewhere the primeval languages have refused to intermingle; the Caucasic has perished, the Mongolic alone surviving. But the dispersion took place at such a remote period that, beyond a general morphological resemblance, few traces can now be detected of any fundamental unity of speech between the Koreans and the surrounding Mongoloid peoples. Like the Manchu, Mongolian, and Japanese, the Korean is a polysyllabic, agglutinating and untoned language, with a rich phonetic system, including as many as fourteen vowels and several gutturals and aspirates. In structure and vocabulary it seems to approach nearest to the Japanese, with which W. G. Aston has compared it.[1]

The national writing system is purely phonetic, consisting of a syllabic alphabet of great antiquity, but unknown origin. It is probably an offshoot of the common alphabetic system formerly diffused throughout East Asia and Malaysia, and scattered members of which are still found amongst the Lolo and Mosso of South-west China, the Tagalas and Bisayans of the Philippine Archipelago, the Korinchi, Rejangs, and Lampungs of Sumatra, and the Dravidians of Southern India. In Korea, however, the literati use the Chinese ideographic system exclusively, leaving the despised native writing to women and children. This alphabet may be seen in the first volume of Dallet's "Histoire de l'Eglise de Corée," which has hitherto been almost our only authority on the subject of the Korean language and literature. Last year, however, a large Korean-French dictionary and a Korean grammar in French were published in Tokio. There is also a "Korean Reader," by Ross (Shanghai, 1879), which the writer has not seen.

A. H. KEANE

---

[1] The language of Ernst Oppert is conclusive on this point: "Unter den vielen Thausenden, die mir während meiner Reisen im Lande zu Gesicht gekommen, habe ich sehr viele von so edeln und charaktervollem Gesichtsausdruck gefunden, dass man sie, wären sie nach unserer Sitte gekleidet gewesen, für Europäer hätte halten können. Auch unter den Kindern war eine grosse Anzahl durch *ihre schönen regelmässigen Züge und rosige Hautfarbe, ihr blondes Haar und die blauen Augen* so auffällig, dass sie von Europäischen Kindern kaum zu unterscheiden waren, und ich mich des Eindrucks ihrer Abstammung von Europäern nicht zu erwehren vermochte, bis bei weiterem Eindringen ins Land diese Erscheinung eine sehr häufige und alltägliche wurde und diese zuerst gefasste Ansicht als irrig zurückgewiesen werden musste." "Reisen Nach Korea. Leipzig, 1881, p. 8. However untrustworthy this writer may be in other respects, his evidence on this question may be unhesitatingly accepted, agreeing as it does with that of so many other observers.

[1] "It seems probable that the distance which separates Japanese from Korean is not greater than that which lies between English and Sanskrit. . . . Everything considered we may regard them as equally closely allied with the most remotely connected members of the Aryan family." (*Journal* of the Royal Asiatic Society for August, 1879.) In this awkwardly worded sentence the writer does not mean to say that Japanese and Korean are allied to Aryan, but that they are as nearly related to each other as are the most remotely connected members of the Aryan family to each other.

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA[1]

III.—*Variegation and Retrogression*

SO far we have spoken for the most part as though every flower were of one unvaried hue throughout. We must now add a few considerations on the subject of the spots and lines which so often variegate the petals in certain species. In this connection a hint of Mr. Wallace is full of meaning. Everywhere in nature, he points out, spots and eyes of colour appear on the most highly-modified parts, and this rule applies most noticeably to the case of petals. Simple regular flowers, like the buttercups and roses, hardly ever have any spots or lines; but in very modified forms like the labiates and the orchids they are extremely common.

Structurally speaking, the spots and lines seem to be the direct result of high modification; but functionally, they act as honey-guides, and for this purpose they have no doubt undergone special selection by the proper insects. The case is just analogous to that of the peacock's plumes or the wings of butterflies. In either instance, the spots and eye-marks tend to appear on the most highly-modified surfaces; but they are perpetuated and intensified by special selective action. Lines are comparatively rare on regular flowers, but they tend to appear as soon as the flower becomes even slightly bilateral, and they point directly towards the nectaries. Hence they cannot be mere purposeless products of special modification; they clearly subserve a function in the economy of the plant, and that function is the direction of the insect towards the proper place for effecting the fertilisation of the ovary. In the common rhodendron, the connection can be most readily observed with the naked eye, and the honey tested by the tongue. In this case, one lobe of the corolla secretes a very large drop of nectar in a fold near its base, and the lines of dark spots appear on this lobe alone, pointing directly towards the nectariferous surface.

The *Geraniaceæ* afford an excellent illustration of the general principle. They are on the whole a comparatively high family of polypetals, for their ovary tends to become compound and very complicated, and they have many advanced devices for the dispersion of their seeds. *Oxalis corniculata*, our simplest English form, is pale yellow: *O. acetosella* is white, with a yellow base, and its veins are delicately tinged with lilac. The flowers of *Erodium* and *Geranium*, which are much more advanced, are generally pink or purplish, often marked with paler or darker lines. For the most part, however, these regular forms are fairly uniform in hue; but the South African *Pelargoniums*, cultivated in gardens and hot-houses, are slightly bilateral, the two upper petals standing off from the three lower ones; and these two become at once marked with dark lines, which are in some cases scarcely visible, and in others fairly pronounced. From this simple beginning one can trace a gradual progress in heterogeneity of colouring, till at last the most developed bilateral *Pelargoniums* have the two upper petals of quite a different hue from the three lower ones, besides being deeply marked with belts and spots of dappled colour. In the allied *Tropæolum* or Indian cress (Fig. 21) this tendency is carried still further. Here, the calyx is prolonged into a deep spur, containing the honey, inaccessible to any but a few large insects; and towards this spur all the lines on the petals converge.

In most regular flowers, the lines are mere intensifications (or diminutions) of the general colouration along the veins or ribs of the corolla; and they point towards the base or claw of the petal, where the honey is usually secreted. But in irregular flowers, we often get a higher modification of colour, so that one region of the petal is yellow or white, while another is pink or blue; and these regions often run transversely, not longitudinally. Such modifications usually affect the most highly-altered parts of the irregular flower.

The common wild pansy, *Viola tricolor*, affords a good example of complex variegation. Its flowers are purple, white, or yellow; or have these pigments variously intermixed. The two upper pairs of petals are usually the most coloured; the lower one is broadest, and generally yellow at the base, with dark lines leading towards the spur. *Viola palustris* exhibits the same tendency in a less degree; it is pale blue, with purple streaks. The whole family is immensely interesting from the present point of view, and should be closely observed by the student at first hand.

Among regular *Corollifloræ*, variegation is not very common, though it occurs much oftener than in the polypetalous classes, especially at the throat of the tube, as in the forget-me-nots (*Myosotis*); but in irregular *Corollifloræ* it is exceedingly frequent. The *Lentibulaceæ* and other small families afford several examples. In the great order of *Labiatæ*, the highly modified lower lip is very often spotted, especially where it is most developed. This is the case in *Stachys silvatica*, *Lamium purpureum*, *Galeopsis tetrahit*, *Calamintha acinos*, *Nepeta cataria*, *N. glechoma*, *Ajuga reptans*, *Scutellaria galericulata*, and many other species. Several exotic kinds show the same tendency in a more marked degree.

The *Scrophularineæ*, however, form perhaps the best example of any. We have noticed already that comparatively few of these are as blue or as purple as might be expected from their high organisation. The explanation is that they have mostly got beyond the monochromatic stage altogether, and reached the level of intense variegation. They are, in fact, a family with profoundly modified flowers, most of which are very specially adapted to very exceptional modes of insect fertilisation. The *Veronicas* alone among our English genera are simply blue, with white or pink lines; the others are mostly spotted or dappled. *Antirrhinum majus* is purple, sometimes crimson or white, with the curiously closed throat a bright yellow. *Linaria cymbalaria* is blue or lilac, with white patches, and the palate a delicate primrose. *L. spuria* is yellow, with a purple throat. *L. minor* is purple, with a white lower lip and yellow palate. The very strange flowers of *Scrophularia* have a curious, indescribable mixture of brown, green, dingy purple, and buff. *Sibthorpia* is pink, with the two smaller lobes of the corolla yellow. *Digitalis purpurea*, the foxglove, is purple, spotted with red and white. *Euphrasia*, eyebright, is white or lilac, with purple veins, and the middle lobe of the lower lip yellow. *Melampyrum arvense* is red, with pink lips and a purple throat. As a rule, the spots or patches of intrusive colour are developed transversely near the palate or around the throat. Purple, red, or blue appear to be the prevalent ground-tones, with white and yellow introduced as contrasted tints.

Among Monocotyledons, such plants as the highly modified *Iris* genus show similar results. Our own *I. fœtidissima* has blue sepals, with yellow petals and spathulate stigmas, all much veined. The *Orchidaceæ* exhibit the same tendency far more markedly. *Orchis mascula*, *O. maculata*, *O. laxiflora*, and many other British species have the lip spotted (Fig. 22). In *O. militaris* and *O. hircina*, the variegation is even more conspicuous. In *O. ustulata*, the spots on the lip are raised. The problematical bee-orchid, *Ophrys apifera*, is singularly dappled on the lip and disk, and has the sepals different in colour from the rest of the flower. *Aceras anthropophora*, the man-orchid, has green sepals and petals, edged with red, and a yellow lip, pink fringed. *Cypripedium calceolus*, the lady's slipper, *Cephalanthera grandiflora*, white helleborine, and most other British species, are similarly very diversified in colour. As to the exotic species, some of them are more peculiarly tinted and blended with half a dozen dif-

---

[1] Continued from p. 326.

ferent hues than any other forms of flowers in the whole world.

On the other hand, primitive yellow flowers of the earliest type never have any lines or spots whatsoever.

Besides the complications introduced by variegation, we have also to consider those introduced by retrogression. Flowers which have reached a given stage in the progressive scale of colouration often show a tendency to fall back to a lower stage. When this tendency is of the nature of a mere temporary reversion (that is to say, when it affects only a few individuals, or a casual variety), it may conveniently be described as Relapse. When, however, it affects a whole species, and becomes fixed in the species by a new and presumably lower adaptation, it may best be styled Retrogression.

Primary yellow flowers, like the buttercups and potentillas, show little or no tendency to vary in colour in a state of nature. They have never passed through any earlier stage to which they can revert; and they are not likely to strike out a new hue for themselves.

Some white flowers, on the other hand, show a decided tendency occasionally to revert to yellow, especially in the simpler orders. *Erysimum orientale* varies from white to pale primrose. *Raphanus raphanistrum*, as already noted, is usually even lilac, often white, and on the sea-shore yellow. The white cistuses often revert to a pale sallow tinge. In some roses, the throat becomes yellow in certain specimens. Stitchwort occurs yellow near Exeter. In several other cases, stray yellow specimens of normally white species are not uncommon.

Fig. 21.—Flower of Indian Cress, orange with dark lines: the honey-guides point directly towards the long spur.

Pink and red flowers almost invariably revert in many individuals to white. A few typical instances must suffice. All the British roses are reddish pink or white. So are *Saponaria officinalis*, and many pinks. *Malva moschata* runs from rose-coloured to white; *M. rotundifolia* from pale lilac-pink to whitish. *Erodium cicutarium* has rosy or white petals; all the geraniums occasionally produce very pale flowers. White varieties of heaths are frequent in the wild state. Where the red or purple is very deeply engrained, however, as in labiates, reversion to white occurs less commonly. But almost all pink or red flowers become white with the greatest readiness under cultivation.

Blue flowers in nearly every case produce abundant red, pink, and white varieties in a state of nature. It would seem, indeed, as though this highest development of colour had not yet had time thoroughly to fix itself in the constitution of most species. Hence individual reversion is here almost universal as an occasional incident in every species. The columbine (*Aquilegia vulgaris*) is blue or dull purple, sometimes red or white. The larkspur (*Delphinium ajacis*) often declines from blue to pink or white. The monkshood (*Aconitum napellus*) is an extremely deep blue, very rarely white. White violets everybody knows well. The rampions (*Phyteuma*) vary from blue to white; so do many of the campanulas. *Gentiana campestris* is sometimes white. In most *Boragineæ*—for example, in borage, viper's bugloss, and forget-me-not—pink and white varieties are common. Pink and white *Veronicas* also occur in abundance among normally blue species. *Prunella vulgaris* occasionally produces rosy or white blossoms. White wild hyacinths are often gathered. Many other cases will suggest themselves to every practical botanist.

Blue flowers, however, very seldom revert to yellow. As a rule, the blue goes back only as far as those shades from which it has more recently been developed. This is, perhaps, the true rationale of De Candolle's law of xanthic and cyanic types.

Fig. 22.—Spotted Orchid, purple with white patches: type of highly developed bilateral monocotyledons.

With the light thus cast upon the question to guide us, we may pass on to the general consideration of Retrogression in colours. Certain species of advanced families have apparently found it advantageous in certain circumstances to revert to colours lower in the scale than the normal hue of their congeners. The reasons for such Retrogression are often easy enough to understand.

We may take the evening campion (*Lychnis vespertina*) as a good example. This white flower, as we saw, is evidently descended from the red day campion (*Lychnis diurnia*), because it is still often pale pink, especially towards the centre, verging into white at the edge. But it has found it convenient to attract moths and be fertilised by them; and so it has lost its pinkness, because white is naturally the colour best seen by crepuscular insects in the dusky light of evening. Sir John Lubbock notes that such evening flowers never have any spots or lines as honey-guides on the petals.

Fig. 23.—Section of Deadnettle, retrogressionary white, with dark spots on lip. Fig. 24.—Common Toadflax, yellow, with the lip orange, acting as guide to the honey concealed in the long spur.

The evening primrose (*Œnothera biennis*) is another excellent instance of the same sort. It belongs to the family of the *Onagraceæ*, which are highly evolved polypetalous plants, with the petals reduced to four or two in number, and placed above instead of below the ovary. We should thus naturally expect them to be pink or lilac, and this is actually the case with most of our native species. Why, then, is the evening primrose yellow? Because it is a night-flowering plant, fragrant in the evening, and its pale yellow colour makes it easily recognisable by moths. In this case, however, two points mark it off at once from the really primitive yellow flowers. In the first place, it has not the bright golden petals of the buttercup, but is rather more of a primrose tint; and this is a common distinguishing trait of the later acquired yellows. In the second place, it belongs to a genus in which red and purple flowers are common, whereas the buttercups are almost all yellow or whitey-yellow, and the potentillas mostly yellow or white. In short, primitive yellow flowers are usually golden, and belong to mainly yellow groups: reverted yellow flowers are often primrose orange, or dull buff, and occur sporadically among blue, red, or purple groups.

Fig. 25.—Corn bluebottle, bright blue, highest type of Cynaroid composite

There are other cases less immediately apparent than these. For instance, *Lamium galeobdolon*, a common English labiate, belonging to a usually purple or blue family, is bright yellow. But we can form some idea of how such changes take place if we look at the pansy, which we have seen reason to believe is normally violet-purple, but which usually has a yellow patch on the lowest petal. In the pansy's var. *lutea*, the yellow extends over the whole flower, no doubt because this incipient form has succeeded in attracting some special insect, or else grows in situations where yellow proves more conspicuous to bees than blue or purple. So, again, another English labiate, *Galeopsis tetrahit*, the hemp-nettle, has a pale purple or white corolla, sometimes with a tinge of yellow in the throat; and in the var. *versicolor*, the yellow spreads all over the flower, except a purple patch on the lower lip. In *G. ochroleuca*, the whole corolla has become pure yellow. In this way, one can understand the occurrence of such a flower as *Lamium galeobdolon*, especially since an allied species, *L. album* (Fig. 23), is white, and all the genus is extremely variable in colour. Indeed, it is to be noted that the yellow labiates do not commonly occur among the less developed thymes, mints, and marjorams, but among the extremely specialised *Stachydeæ*, which have very modified flowers, and usually variegated or spotted lips. They seem to be essentially reversionary forms from purple or blue species, spotted with yellow.

Another hint of Retrogression is given us by flowers like our English balsams, *Impatiens noli-me-tangere* and *I. fulva*, in the fact that their yellow is generally dappled with numerous spots of deeper colour. The balsams are highly modified irregular *Geraniaceæ*, sepals and petals being both coloured; and at first sight it seems curious that our species should be yellow, while the simpler *Geraniums* and *Erodiums* are pink or red. But the genus as a whole contains many red and variegated species, and alters in colour with much plasticity in the hands of gardeners. *I. noli-me-tangere* is pale yellow, spotted with red; *I. fulva* is orange, dappled with deep brown. Both are almost certainly products of retrogressive selection.

In the *Primulaceæ*, we find similar instances. *Hottonia palustris*, a less developed form, is rosy lilac. *Cyclamen europæum* is white or rose-coloured. *Trientalis europæa* is white or pale pink, with a yellow ring. From such a stage as this, it is easy to get at our primroses, cowslips, and oxlips, which have pale yellow corollas, with orange spots at the throat. Indeed, one English species, *Primula farinosa*, is pale-lilac, with a yellow centre: and this might easily, under special circumstances, become pale primrose all over. The cultivated varieties of the cowslip, called Polyanthuses, readily assume various tints of orange, red, and pink, always at the edge, the deep yellow of the throat remaining unchanged.

Fig. 26.—Section of Ligulate Composite, all the florets retrogressionary yellow.

The colours of many *Scrophularineæ* may be explained in the same way. Perhaps the yellow of the mulleins is primitive; but as some species are white or purple, it is just as likely to be retrogressive. In *Linaria*, we may almost be sure that retrogression has taken place; for we can trace a regular gradation from lilac flowers with a yellow palate, like *L. cymbalaria*, to pale yellow flowers, like *L. vulgaris*, which has the mass of the corolla primrose, and the palate orange (Fig. 24). *Mimulus luteus* is also yellow, but it is usually marked inside with small purple spots, and sometimes has a large pink or red patch upon each lobe. In *Melampyrum cristatum*, the yellow corolla is variegated with purple: in *M. pratense*, it has the lip deeper in hue. All these genera include many purple and variegated species: and the yellow members almost always bear evident marks of being descended from polychromatic ancestors.

The case of the yellow *Compositæ*, especially the *Ligulatæ*, is more difficult to decide. It would seem as though these plants, which have all their florets ligulate, must be more highly developed than the *Corymbiferæ*, which have only the ray-florets ligulate, or than the *Cynaroideæ*, which have no ligulate florets at all. Hence we should naturally expect them to be blue or purple, whereas they are for the most part yellow of a very primitive golden type, while the ray-florets of the Corymbifers are usually white or pink, and all the florets of the Cynaroids are usually purple. The following hypothetical explanation is suggested as a possible way out of this difficulty.

The primitive ancestral composite had reached the stage of blue or purple flowers while it was still at a level of development corresponding to that of the scabious or *Jasione*. The universality of such colours among the closely allied *Dipsaceæ*, *Valerianeæ*, *Lobeliaceæ*, and *Campanulaceæ*, adds strength to this supposition. The central and most primitive group of composites, the Cynaroids, has kept up the original colouration to the present day; it includes most of the largest forms, such as the artichoke, and it depends most of any for fertilisation upon the higher insects. All our British species (except the degenerate *Carlina*) are purple, sometimes reverting to pale pink or white, while *Centaurea cyanus* (Fig. 25), our most advanced representative of the tribe, rises even to bright blue.

Next to the Cynaroids in order of development come the Corymbifers, some of which have begun to develop outer ligulate rays. Here the least evolved type, *Eupatorium*, with few and relatively large florets, is usually purple or white, never yellow. But as the florets grew smaller, and began to bid for the favour of many miscellaneous small insects, reversion to yellow became general. In a few cases here and there we still find purple or white central florets, as in *Petasites vulgaris*, the butter-bur; but even then we get closely related forms, like *Tussilago farfara*, colts-foot, which have declined to yellow. The smallest and most debased species, such as *Solidago virga-aurea*, golden rod, *Tanacetum vulgare*, tansy, and *Senecio vulgaris*, groundsel, have all their florets yellow and similar; unless, indeed, like *Gnaphalium* and *Filago*, cud-weed, *Artemisia absinthium*, wormwood, or *Xanthium strumarium*, burweed, they have declined as far as colourless or green florets, in which case they must be considered under our next head, that of Degeneration. On the other hand, the larger and better types of Corymbifers began a fresh progressive development of their own. In many *Senecios*, *Inulas*, *Chrysanthemums*, they produced yellow ray florets, similar in colour to those of the disk. In *Chrysanthemum leucanthemum*, *Anthemis cotula*, *Matricaria inodora*, &c., these rays, under the influence of a different type of insect selection, became white. In the daisy they begin show signs of pink, and in the *Asters*, *Cinerarias*, &c., they become lilac, purple, and blue. Complicated as these changes seem, they must yet have taken place two or three times separately in various groups of Corymbifers, for example, in the *Asteroideæ*, the *Anthemideæ*, and the *Senecionideæ*.

The Ligulates were again developed from yellow-rayed Corymbifers by the conversion of all the disk florets into rays. Appealing for the most part to very large and varied classes of miscellaneous insects, they have usually kept their yellow colour (Fig. 26); but in a few cases a fresh progressive development has been set up, producing the violet-blue or purple florets of the salsify (*Tragopogon porrifolius*), the deep blue *Sonchus alpinus*, and the bright mauve succory, *Cichorium intybus*. As a whole, however, the Ligulates are characterised by what seems a primitive golden yellow, only occasionally rising to orange-red or primrose in a few hawkweeds.

That this hypothetical explanation may be the true one seems more probable when we examine the somewhat similar case of the *Stellatæ*. Here it seems pretty clear that mere dwarfing of the flowers, by throwing them back upon earlier types of insect fertilisation, has a tendency to produce retrogression in colour. Even in the more closely allied *Dipsaceæ*, *Valerianeæ*, and *Campanulaceæ*, we see a step taken in the same direction, for while the large-flowered *Campanulas* and *Scabiosas* are bright blue, the smaller flowered teasel (*Dipsacus silvestris*) is pale lilac, the *Valerianas* are almost white, and the *Valerianellas* are often all but colourless. In the *Stellatæ*, the same tendency is carried even further. As a whole, these small creeping weeds of the temperate regions form a divergent group of the tropical *Rubiaceæ* (including *Cinchoniaceæ*), from which they are clearly derived as a degraded or dwarfed sub-order. Now, the tropical *Rubiaceæ* have tubular blossoms with long throats, and as a rule with five lobes to the corolla; but many of the Stellates have lost the tube and one corolla lobe. *Sherardia arvensis*, which has departed least of our British species from the norma of the race, has a distinct tube to the corolla, and is blue or pink. *Asperula*, which approaches nearer to the retrograde *Galiums*, has one pale lilac species and one white. The *Galiums* have no corolla-tube at all, and most of them are white; but two British species, *G. verum* and *G. cruciata*, are yellow, and one of these has become practically bi-sexual—a common mark of Retrogression. *Rubia peregrina* is even green. This clearly marked instance of Retrogression from blue through lilac and white to yellow makes the case of the Composites easier to understand. No doubt the dwarfed northern Stellates have found that they succeeded better by adapting themselves to the numerous small insects of the fields and hedgerows, and therefore have fallen back upon the neutral colours, white and yellow.

After so many instances of more or less probable Retrogression, it will not surprise us to learn that in an immense number of other cases there is good reason to suspect some small amount of dwarfing or even Degeneration. It may have struck the reader, for example, when we were dealing with the Crucifers, that many of the smaller white forms were apparently lower in type than large and brilliant yellow flowers like the charlocks. That is quite true; but then, many of these small types are demonstrably dwarfed and slightly degraded, as, for example, *Cardamine hirsuta*, which has usually only four stamens instead of six, thus losing the most characteristic mark of its family. In *Senebiera didyma*, the petals have generally become quite obsolete; in some species of *Lepidium*, *Arabis*, *Draba*, &c., they are inconspicuous and often wanting. So in the smaller *Alsineæ* there are many signs of Degeneration. The normal forms of *Caryophyllaceæ* have two whorls of five stamens each; but these little creeping or weedy forms have often only one whorl, as in *Holosteum*, some *Cerastiums*, the smaller *Stellarias*, *Spergula*, *Polycarpon*, &c. In *Sagina*, *Cherleria*, and other very small types, the petals are often or always wanting. Indeed, most botanists will probably allow that nearly all our minute-flowered species, such as *Montia fontana*, *Claytonia perfoliata*, *Elatine hexandra*, *Radiola Millegrana*, *Circæa lutetiana*, *Ludwigia palustris*, *Peplis Portula*, *Tillæa muscosa*, *Myriophyllum spicatum*, *Hippurus vulgaris*, *Centunculus minimus*, and *Cicendia pusilla*, are distinctly degenerate forms. Though obviously descended from petaliferous ancestors, and closely allied with petaliferous genera or species, many of them have lost their petals altogether, while others have them extremely reduced in size. In several cases, too, the number of sepals, petals, or stamens has been lessened, and the plant as a whole has suffered structural degradations. Most of these dwarfed and degenerate flowers, if they have petals at all, have them white or very pale pink.

Readers of Sir John Lubbock's admirable little book on "British Wild-Flowers in Relation to Insects" will readily understand the reason for this change. They will remember that white flowers, as a rule, appeal to an exceptionally large circle of insect visitors, mostly of small and low grades. Hence, some among these very small flowers may often succeed, in certain positions, better than larger ones. Moreover, they will recollect that in numerous instances the larger blossoms of each family are so exclusively adapted to insect fertilisation that they cannot fertilise themselves; while among the smaller blossoms alternative devices for self-fertilisation commonly come into play after the flower has been open for some time, if it has not first been cross-fertilised. Structural considerations show us that in most of such instances the larger and purely entomophilous flowers are the more primitive, while the smaller and occasionally self-fertilising flowers are derivative and degraded, having usually lost some of their parts. Hence, in tracing the progressive law of colouration in the families generally, it is necessary, for the most part, to consider only the larger and more typical species, setting aside most of the smaller as products of degeneration. GRANT ALLEN

(*To be continued.*)

NOTE ON THE HISTORY OF OPTICAL GLASS

M. FEIL has been good enough to send us the following interesting particulars of the life of Pierre Louis Guinaud :—

Pierre Louis Guinaud was born at Bresset in the canton of Neuchatel, Switzerland, in 1742, and died in 1821. He was nearly sixteen years old when Herschel visited Switzerland, and with Alschneider made some telescopic experiments on the Tête Doran. Young Guinaud, who acted as shepherd by day, and at night worked in a bell manufactory, occasionally was present at the meetings of these gentlemen, and attracted their attention and good will by many services.

His curiosity was greatly aroused, and after having been allowed to look through the telescope, he asked Herschel to dismount the instrument, as he wished to see how it was made; doubtless struck by his wonderful intelligence, the illustrious *savant* showed him the details of its construction.

The following year this gentlemen returned to Switzerland with Dollond and Faraday. Young Guinaud must have utilised the intervening time, for he showed Herschel, whom he was able to call his benefactor, a telescope which he himself had made, the mirror being of bell-metal. Imperfect as such an instrument must necessarily have been, it proved his strength of will and aptitude for optics.

He had pondered over the subject and asked why large object-glasses had not been made? There are no glasses in existence suitable to make them," was the answer. "Make some, if you can," said Alschneider. "I will make some," replied Guinaud. But he required money. He set to work, and, being a clever workman, soon invented the bells of repeaters, which proved very lucrative. All that he earned was devoted to the establishment of small glass-works. What power of research and perseverance must this man have possessed, who, without any other resource but his genius, started the most difficult branch of glass making, in order to solve a problem which was incomprehensible to Faraday and Dartigères? For ten years everything was devoted to his work. One casting failed, and was thrown into the torrent which flowed at the foot of the mountain on which he had built 'his factory. He had chosen the highest and most inaccessible point, having to defend himself against the ignorance of his neighbours, who treated him as a sorcerer, and several times his place was sacked. He utilised a stream of water in order to work a hydraulic wheel for the pulverisation of these materials, the sawing and working up of these blocks of glass. Nevertheless, the attention of the scientific world was already drawn to the modest worker. Alschneider had become his friend. About 1806 he sold a disc of six inches to Lerebours, and at nearly the same time he sent an eight-inch to Dollond; the problem was solved. He furnished Panchoni and Lerebour with discs of twelve inches. The twelve-inch object-glass belonging to Causham was bought for 2,500 francs by Faraday. Alschneider begged him to go to Munich and associate himself with Fraunhofer. But at the end of about three years the desire to see his mountains again took possession of him, and he renounced all his advantages and returned to continue his work alone. France offered him a pension from the state, a secret patent for fifteen years, and a factory fully established; but he refused to accede to the offers of the minister of Vitellius, and died in 1821. After his death his son, Henri Guinaud, who had always lived in France from the age of fifteen, was put into communication by Lerebours with MM. Bontemps and Thibaudau, proprietors of the glass-works at Choisy-le-Roi. He had seen several experiments during the journeys he had taken with his father. He taught these gentlemen all he knew of his father's processes, but, obliged by penury to quit them, he returned to Paris, and founded, with his son-in-law, M. Feil, my father, a small glass-work in the Rue Mouffetard. This was in 1832.

In 1838 Henri Guinaud received the gold medal of the Academy of Sciences, in 1839 the great prize in astronomy, one part of which was given to M. Bontemps. He presented to the Academy of Sciences a disc of eighteen inches diameter. I succeeded him in 1848, and was his pupil for six years. He died in 1851, carrying with him the regrets of all scientific men, who, like the Aragos, Gambays, Thénards, and Dumas, had appreciated his cleverness and his talents, and who were his friends and protectors.

NOTES

THE French Association for the Advancement of Science meets this year at La Rochelle, on the 24th inst., for its eleventh session. M. Janssen is the President Elect. Two lectures are to be delivered, one by M. Bouquet de la Grye, on the deep water harbour of La Rochelle; the other by M. Hospitalier, on the electric light. There will be excursions to the places where oysters and mussels are cultivated. Deep-sea dredging will take place on board the *Ardisnade*, under the direction of Prof. Giard, of Lille. A reduction of 50 per cent. will be granted on the French railways to the members of the Association. Among foreign *savants* expected to attend the meeting are Prof. Hennessy of Dublin, Prof. van Beneden of Louvain, with several other Belgians, Prof. Baehr of Delft, and two other Dutch *savants*, Signor Denza, of Moncalieri Observatory, and two other Italians, Chevalier di Silva, Royal Architect, from Lisbon, Prof. Vittanova of Madrid, and M. de Loriol of Geneva. Among the subjects of papers we note briefly the following :—The Channel Tunnel; American glaciers; transformation of work into heat, and reciprocally; marbles of Italian quarries; employment of portable railways in the war in Tunis; geodetic works in Italy; the salubrity of collective dwellings; aërodynamics and solar heat; the topoveloce; a new gyroscopic box; a geometrical generation of Fraunhofer's lines; theory of vowels; isotherms on mountains; registering capillary electrometer; new pressure-anemograph; best coloured signals for beacons, &c.; sulphurous acid in Lille atmosphere; aërial navigation; photometry for light of different colours; severe winters; distribution of the atmosphere in the two hemispheres; ammoniacal fermentation; determination of salicylic acid in alimentary substances; action of oxalic acid on polyatomic alcohols; formation of alkaloids in protoplasm; bases of the quinoleic series; electro-therapeutic treatment of vomiting; double consciousness; teas of commerce; anæsthesia in croup; anthropology of evolution; the cause of goitre; intestinal parasites of oysters; thermal waters in the

Mediterranean basin; physiology of the nervous system; ocular hygiene; yellow fever; the Verbenaceæ; mints of France; European clover; funeral furniture of a dolmen; a palæolithic and neolithic station (see the *Revue Scientifique*, July 27 and August 5).

THE remains of the late Prof. Balfour were, on Saturday, interred at Whittingham.

THE British Medical Association is holding its fiftieth annual meeting this week (beginning Tuesday, the 8th inst.) at Worcester, the city of its birth, under the presidency of Dr. W. Strange, of Worcester Infirmary. Among other events, a bust of Sir Charles Hastings (to whom the Association mainly owes its origin) is to be presented to the city.

A SEVERE earthquake is reported to have been felt in Chios (August 7), but no damage was done.

IT has been announced that an "Exhibition of Practical Electric Development," with reference chiefly to telephones, electric lighting, transmission of power, and the economical application of electric energy to practical work, will be held in the Royal Aquarium, Westminster, from November 1, 1882, till March 1, 1883. Prizes amounting to a total of 1000*l.* will be awarded by a Committee which the scientific societies will be invited to nominate. The subjects (in brief) are:—1. Best system of storage and generator for railway systems; generator to be worked from axle of train. 2. Best systems of storage battery, large and small. 3. Design in models, showing the best method of utilising (*a*) wind or water, (*b*) tidal forces for electrical storage. 4. Best electromotor for stationary or tram-car work (three kinds). 5. Best automatic (shunt or otherwise) system of dynamos for compensating change of resistance in external circuit, and economising power absorbed by machine. (6) Best model or drawing (with estimates) of central stations for 20,000 electric lights over a radius of one mile. 7. Best electric meter for houses. 8. Best set of twenty-five fancy fittings for electroliers. 9. Best set of fittings for restaurant or hotel bars, and counters. 10. Best application of electric light fittings to photographic studio. 11. Best fittings, &c., for drawing and other private rooms. 12. Best system of street mains or leads for public supply. 13. Best electric couplings for trains. 14. Best photometer, if possible, self-recording. 15. Best electro dynamo-meters (*a*) for direct, and (*b*) for alternating currents; both in one instrument. 16. Best thermopile for utilisation of waste heat and conversion into light or power by means of storage. 17. Best lamp for mine or sub-marine operations. 18. Most complete apparatus for remedial appliances, especially with regard to use of a bath in which the patient is immersed. Applications for space must be made (for England) not later than August 21.

THE *Times* Correspondent in Paris mentions having seen, at a recent popular *fête* at the Tuileries, a solar apparatus set in motion a printing machine, which printed several thousand copies of a specimen newspaper called the *Soleil Journal*. He also saw cider and coffee made with its aid, and a pump set in motion. He suggests the use of such apparatus for troops in Egypt and India.

WE are glad to learn that there is some prospect of an addition being made shortly to the small number of technical schools at present existing in this country, and that in a district where such a school, if properly organised, should prove of great utilty, viz., Cleveland. Mr. Samuelson, M.P., whose active interest in the subject of technical education has been so fruitful, has been discussing with some of the leading manufacturers in Cleveland the propriety of establishing a science school, having special reference to chemistry and metallurgy, at Middlesborough, and we understand that the proposal has been received with general approbation, and a definite scheme will soon be put forth. It is estimated by Col. Festing that a building, including a lecture theatre to hold over 200, and all necessary accommodation, would cost at least 2500*l.*, and that the laboratory fittings, &c., would cost 600*l.*; but it would be essential to look for a present expenditure of from 5000*l.* to 6000*l.*, exclusive of land. As to maintenance, the institution would have a fixed revenue from fees; there will be payment for results, and some help towards a sustentation fund is looked for from the City Guilds of London. The cost of laboratory fittings would doubtless be partly met from South Kensington. Mr. Samuelson is prepared we hear, not only to contribute liberally towards the funds required for the institution, but also to give his personal and practical aid in the working out of the scheme. A meeting of those who sympathise with the movement will shortly be held, at which he and others will fully explain the objects and mode of operation. We trust that in the organisation of this school, due regard will be had to the interests of pure science, a thorough grounding in which is essential to true progress, on the part of the apprentice, in technical study.

MR. O'NEILL, H.B.M. Consul at Mozambique, has recently reported to the Foreign Office that from Mr. James Heathcote, of Inhambane (who was employed by him for the recovery of the body of the late Capt. Wybrants), he has received information of the discovery of a considerable tract of copal forest. Mr. Heathcote writes: "The forest where I obtained this gum, of which I send you specimens (I have collected six tons) is fully 200 miles long. It is a belt which runs parallel with the coast, and is midway between the coast and the first range of mountains. From Inhambane it is nearly 100 miles to get right into it." The distance of the forest from Inhambane is a little great, and may retard its being opened up; but its discovery adds to the known wealth of the district, and a new export to the place. Mr. Heathcote points out the following curious coincidence, and although it may not be the first time that attention has been drawn to it, the Consul mentions it: "The native name of this gum is 'Stakate' and 'Staka.' The Zulu name for gum is 'Inthlaka.' The name 'Stacte' mentioned in Exodus xxx. 34 (this is believed to be the gum of the Storua tree, *Styrax officinale*), would be pronounced as the above native name. The tree domineers over all, and standing in any place overlooking the forest, you see here and there trees growing as it were in a hay-field. The gum has a beautiful odour if pounded and burnt, also if boiled in a pot of water." The ordinary gum copal tree of the mainland of Zanzibar and Mozambique, though as a rule lofty, is by no means of the striking stature indicated by Mr. Heathcote's comparison.

THE Iron and Steel Institute hold an Autumn meeting in Vienna this year, from Tuesday, September 19th to the 23rd. Besides visits to engineering and other works in Vienna, and various entertainments, alternative excursions are arranged (for the 22nd) to Leoben and Gratz in Styria, and to Buda-Pesth, in Hungary.

THE American Committee for the Darwin Memorial (to co-operate with the English Executive Committee) has for its chairman Prof. Asa Gray; treasurer Prof. Alex. Agassiz. The other names are those of Baird, Dana, Eliot, Gilman, Hall, Leconte, Leidy, Marsh, Mitchell, Newcomb, Norton, Walker, and Wooley.

THE United States Bureau of Education issued not long ago a circular on the subject of Spelling Reform, which the Commissioner, General Eaton, pronounces to be of great importance. It contains a report, dated 1877, from four or five professors, who, after three years' discussion of the subject by the American Philological Association, were appointed a committee with recommendations which have been carried out as to reorganising the alphabet and cutting types to express distinct sounds now represented by one letter; also a similar Report of the Spelling Reform Association, with such new characters recommended both for printing and writing; and five new rules for writing words with present letters, which have become widely known, and a rather longer code of desirable changes. The circular contains also a sanguine account of the support and success that the movement has had in the States. It is a most interesting *résumé* of what amount of agreement has been arrived at among phonetic spellers and the moderate changes which they urge should be adopted first. But there are signs in it that there is small hope of all English-speaking nations agreeing upon a uniform standard of pronunciation, still less of their agreeing to represent uniformly the sound of such words in print; the result, therefore of the adoption of phonetic spelling must be the break-up of the English language, which it might have been hoped, would have become the language common to at least half the civilised earth. Each country—and it is hard to say how small division of each country—would soon have a brogue of its own, whose steadily increasing differentiation from all others will have nothing to check it. We have before our eyes now the small beginning of a natural confusion of tongues which the Hebrews of old well knew to be a curse, though ignorant of the process of evolution.

A USEFUL little "Guide to Southampton and Neighbourhood" has been prepared by Mr. Thomas W. Shore, of the Hartley Institution in that town, in view of the approaching visit of the British Association. A few pages are devoted to notes on climate, vital statistics, geology, botany, zoology, &c.

A PROPOSAL has been made to the Municipal Council of Paris to give the name of Miss Sophie Germain to one of the newly opened streets. This lady was a clever mathematician, who died about fifty years ago, and left some papers relating to high analysis.

THE Astronomical and Meteorological Bulletin of the Observatory of Rio de Janeiro (April number) has an account of solar observations by M. Lacaille, on nine separate days in February–April, with reference to variations of the solar diameter. The solar image was thrown on a screen which had a series of parallel lines directed perpendicularly to the diurnal motion. The passages of the sun's border over those lines were recorded in a chronograph. Each of the tables (referring to one day's observations) gives the angle of position of the solar equator reckoned from north towards east, the angle, north or south of the solar equator, which the diameter measured makes with the latter, the radius vector of the earth's orbit, and the sun's declination. The difference between the time of passage of the semi-diameter deduced from observation and that given by the *Nautical Almanac* is in general very small; it does not exceed 0·10s.

IN consequence of the long time which elapses between the meetings of the Meteorological International Congress, the President, Dr. Wilde, of St. Petersburg, has decided to form a permanent Committee to meet once a year, in order to examine and record the materials collected within such time. The first meeting of the Committee has just taken place in Copenhagen, lasting from the 2nd to the 5th inst.

THE Argentine Republic is at present organising two stations for observation of the transit of Venus; the first at Buenos Ayres, the second in the south of the province, in the environs of Tandil. One expedition is organised at the expense of the Argentine Government, and the other at that of the province of Buenos Ayres. The instruments have been ordered from M. Gautier, Paris; they are 6 inch and 8-inch equatorials. The two observatories are meant to become permanent; the Republic will then possess three, the principal one being that at Cordoba, established by M. Gould. The enlightened Governor of Buenos Ayres, M. Dando Rocha, has decided to carry out a scientific work of the first importance, viz. measurement of a meridian arc of 7° or 8°, which will serve as base for a geodetic map of the Argentine Confederation, and be of great interest for determining the form of the earth (southern measurements of the kind being very few).

WE have received from M. E. Hospitalier (whose work on the Modern Applications of Electricity, as translated and enlarged by Mr. Julius Maier, we reviewed in NATURE, vol. xxvi. p. 289) a letter, too long to insert in its entirety, complaining that for most of the points adversely criticised by us he is not responsible. He has courteously sent us a copy of the original edition, in French, of his work, that we might assure ourselves that his repudiation of what he justly terms *errors against common sense* was justified. M. Hospitalier protests against having been made to confound the *ampère* with the *coulomb*. He points out that in describing Edison's armature he described it as being founded in principle upon that of Siemens, not that of Gramme. He calls attention to the passage of his work where he says: "La machine Pacinotti a figuré à l'Exposition et a valu à son inventeur un diplôme d'honneur. Sa *priorité* et son identité de principe avec la machine Gramme *ne peut donc être contestée aujourd'hui.*" (The italics are M. Hospitalier's). We willingly accord to M. Hospitalier the claim he makes to repudiate the blunders for which he is not responsible, but we think he is a little too severe when he writes us that he is experiencing the truth of the Italian proverb, *traduttore, traditore.*

WE observe that a correspondent of a daily paper proposes that men addicted to the pursuits of science should be called *scientiates*, after the Italian *scienziati;* and in like manner the studies of science, *sciential* studies (*studj scienziali*). The substitution of the American *scientist* for our unsatisfactory phrase *men of science* is of course much to be deprecated; perhaps we shall come to accept Sir William Thomson's proposed use of *naturalist* for the designation in question, if its sense may be extended. *Scientific studies* is a phrase which cannot be commended for accuracy.

WE have received a letter from Rio de Janeiro stating that M. Crüls, the Imperial astronomer *pro tem.*, has established a time-ball similar to that at the Greenwich Observatory.

EXPERIMENTS have been made at Havre to test a system of telephony between the Roads and the city. They have been so successful that it has been proposed to form a pontoon structure at a distance from the land, on board of which public telephones should be placed for use by the shipping in communicating with the land.

THE credit for the French mission for the Venus transit has been recently voted by both Houses of Parliament, and amounts to 18,000*l.*

THE Budget Committee of the Chamber of Deputies proposes to the House to spend a sum of 3680*l.* for microscopical inspection of bacon and other meat liable to be infected with trichinæ. A special tax will be imposed on such goods for that purpose. There is a decided tendency to make the microscope an instrument of common use in the hands of the French administration.

THE conditions of habitability of Mars are discussed by M. Flammarion in the August issue of his excellent new journal, *L'Astronomie.* With S. Schiaparelli (who describes his recent observations in the same number), he accounts for the striking variability of geographical configuration of the planet by supposed alternate inundations and dessication of water, due to water-transformations much more important than those on our globe. There are also papers on Venus and her satellite, the tides in the Mediterranean, the heavens in August, &c.

A CURIOUS and little-known experiment, showing the resistance of the air in guns, is described by Prof. Daniel Colladon, of Geneva, in a recent letter to M. Melsens (*Bull. Belg. Acad.* No. 6). He was long in the habit of showing it to his classes. It resembles a feat that was sometimes performed by soldiers with the old Swiss carbines. M. Colladon fully charged with compressed air the hollow iron breech of an air-gun, serving as reservoir. Having screwed up the gun, he introduced a round lead ball, running freely, but nearly filling the bore; then, placing the gun vertical, he seized the upper end and pressed his thumb vigorously on the mouth. The gun was then "fired" by an assistant; the thumb remained in position, and the ball was heard to fall back in the bore. Thereupon, after recharging the breech and with the same ball, he shot the latter at a pine board about ·4 in. thick, or a pane of glass, and it passed through. The experiment, M. Colladon says, is without danger, if the operator is sure of the strength of his thumb, if the gun is more than 32 in. long, and if the ball is spherical and nearly fills the gun (in which it must act like a piston). The least uncertainty in the very vigorous pressure of the thumb, and hermetic closure of the gun, may entail serious injury to the thumb. While M. Colladon has repeated the experiment twenty or thirty times, without the least inconvenience either from shock or heat, a trial of it is perhaps hardly to be recommended.

THE additions to the Zoological Society's Gardens during the past week include a Common Raccoon (*Procyon lotor*) from North America, presented by Mr. Mark Vice; a Passerine Owl (*Glaucidium passerinum*), European, presented by Miss Maud Howard; six Common Guillemots (*Uria troile*), European, presented by Sir Hugh Dalrymple, Bart.; an Allen's Porphyrio (*Porphyrio alleni*), captured at sea, presented by Master J. Kennedy; forty Restless Cavies (*Cavia caprera*), British, presented by H.R.H. the Prince of Wales, K.G.; a Four-rayed Snake (*Elaphis quaterradiatus*), South European, presented by Capt. Adams; a Smooth Snake (*Coronella lævis*), British, presented by Mr. W. Penney; an Egyptian Cobra (*Naia haje*) from South Africa, presented by Mr. Eustace Pillans; a Common Viper (*Vipera berus*), British, presented by Mr. H. J. Benwell; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, a Grey Ichneumon (*Herpestes griseus*) from India, a Goffin's Cockatoo (*Cacatua goffini*) from Queensland, a White-headed Sea Eagle (*Haliaetus leucocephalus*) from North America, a Chequered Elaps (*Elaps lemniscatus*) from Brazil, deposited; three Black Lemurs (*Lemur macaco* ♂ ♂ ♀), a White-fronted Lemur (*Lemur albifrons* ♂) a Red-fronted Lemur (*Lemur rufifrons* ♂) from Madagascar, a Cape Hyrax (*Hyrax capensis*) from South Africa, a Westerman's Cassowary (*Casuarius westermanni*) from New Guinea, two Pileated Jays (*Cyanocorax pileatus*) from La Plata, two White-faced Tree Ducks (*Dendrocygna viduata*), two Rufous Tinamous (*Rhynchotus rufescens*) from Brazil, two Tataupa Tinamous (*Crypturus tataupa*) from South America, an Argentine Tortoise (*Testudo argentina*) from the Argentine Republic, two Common Chameleons (*Chamæleon vulgaris*) from North Africa, two Aldrovandi's Lizards (*Plestiodon auratus*) from North-West Africa, purchased; two Mocassin Snakes (*Tropidonotus fasciatus*), born in the Gardens.

THE EXCITABILITY OF PLANTS[1]

IT will be in the recollection of many who are present this evening that in February of last year I had the honour of delivering a Friday evening discourse on a subject which included that which has been announced for to-night. In that lecture I had hoped to present to you a comprehensive view of the excitatory motions both of plants and of animals; that is, of those motions which they perform in response to transitory impressions received by them from outside. I was desirous that the statements that I made to you with reference to animal excitability should be as fully as possible illustrated by experiments, in the carrying out of which much more time was lost than I had reckoned for; so that I was unable even to enter on the second part of my subject. The time at my disposal will not permit me to summarise my last lecture, however advantageous it might be to do so. I must content myself with recalling your attention to one or two fundamental points.

Under the term excitability are comprised all cases in which some definite change in the behaviour of a living structure, whether it be a whole animal or a part, constantly arises as the result of some transitory external influence. But for the purpose in view, those cases only were included (typical of the rest) in which some sort of muscular motion is performed in response to an excitation or stimulus. The effect of such excitation we call the excitatory process, and we say, as the result of observation, that it consists of two phases or stages—namely, the phase of latency, and the phase of visible effect. These were illustrated in the last lecture by a series of experiments in which the excitable tissue of the heart of the frog was used. It was first shown with reference to this tissue that when it is touched (that is excited) with the tip of a glass rod, it undergoes a definite change of form, at the same time doing mechanical work at the expense of material contained in, but not forming part of, its own substance; secondly, that this mechanical effect did not begin until the lapse of an easily measurable period after the excitation, ; it was then pointed out that the interval of time between the prick and the visible or mechanical effect—the change of form, or contraction of the contractile substance—was one during which, though no visible change occurred in the excited part, molecular changes must certainly be in progress, and that these were accompanied by electrical disturbance.

To illustrate this, I demonstrated to you that the electrical change which in all cases accompanies excitation, precedes the mechanical one in time. You will remember that by means of the electric light the outline of the muscle to be excited and the image of the galvanometer mirror were projected on the screen, and that we were able to observe that when the muscle was pricked, the electrical disturbance had time to produce a deflection of the magnet which was visible on the screen before the muscle contracted.

It was further shown that an excitatory effect analogous to that which in muscle constitutes the first phase is produced in nerve, that in both the process of excitation is capable of being propagated in the same sort of way that an explosion is propagated in a train of gunpowder, and, finally, that the existence in nerve of this endowment is the instrumentality by which, in the human body, the will is able to influence and govern all the rest, and to receive influences from outside.

To-night we shall occupy ourselves exclusively with plants. I shall endeavour to show not only that they possess the wonderful property of excitability by which one part is able to influence another part at a distance, but that there is reason for believing that the excitability they possess is essentially of the same nature as that of animal tissue. And now, without further preface, I propose to enter on my subject by first giving you a short account of some of the most instructive instances of excitable plants.

The number of plants which exhibit what is often called irritability is very considerable. I will not weary you with even enumerating them. You will see from the table that they are distributed among a number of natural orders, so that one might be inclined to suppose that in this respect no relation could be traced between the physiological endowments and the morphological characters of a plant. That it is not so we have abundant evidence. Thus in the same genus we may find all the species excitable, though not in the same degree. The extreme sensitiveness of the Chinese Oxalis, formerly called *Biophytum sensitivum*, because it was supposed to be particularly alive, appears in a less degree, but equally distinctly in our own wood sorrel, as well as in the Tree Oxalis of Bengal—the Carambola,[1] which is described in an interesting letter addressed by Dr. Robert Bruce to Sir Jos. Banks, and published in the Philosophical Transactions. Again, in the same order, as, for example, among composite plants, we may have the Thistles, Knap-

---

[1] Lecture delivered at the Royal Institution June 9, 1882, by Prof. Burdon Sanderson, F.R.S.

[1] An account of the sensitive quality of the tree Averrhoa Carambola. By Robert Bruce, M.D. *Phil Trans.*, vol. lxxv. p. 356

weeds, and Hawkweeds, all showing excito-contractility in the same way, although the plants do not at all resemble each other in external appearance. In order to make you acquainted with the mechanism by which the excitable motions of plants are brought about, I will confine myself to a very few examples, selecting, of course, those which have been most carefully investigated.

Every one is acquainted with the general aspect of the sensitive plant. Probably, also, most persons have observed the way in which the leaves behave when one of them is touched, namely, that the leaf, instead of being directed upwards, suddenly falls, as if it had lost its power of supporting itself, and that the little leaflets which spring from the side stalks fold together upwards (Fig. 1). But perhaps every one has not observed exactly how this motion is accomplished, namely, that by means of little cylindrical organs the leaflets are jointed on to side-stalks, the side-stalk on to the principal stalk, and the principal stalk on to the stem. In those little cylinders, the powers of motion of the leaf have their seat. They may, therefore, be called the motor organs of Mimosa. I would ask your attention to their structure.

FIG. 1.—Leaf of Mimosa; *a*, in the unexcited state: *b*, after excitation (after Pfeffer).

In my description I will confine myself to the relatively large joint at the base of the principal leaf-stalk. If you make a section through it in the direction of its length, you find that it consists of the following parts. In the axis of the cylinder is a fibro-vascular bundle; above it are numerous layers of roundish cells with thick walls, and between these there exist everywhere intercellular spaces, which in the resting—that is the excitable—state of the organ, are filled with air. The surface is covered by epidermis. Below the axial bundle there are equally numerous layers of cells, but they differ from them in this respect, that their walls are more delicate (Fig. 2). And now let us study the mechanism of the motion. The literature of this subject is voluminous. Substantially, however, we owe the knowledge we possess to two observers—E. Brücke,[1] who studied it in 1848, and Pfeffer,[1] whose work appeared in 1873. I must content myself with the most rapid summary.

Let me begin by noticing that Mimosa, in common with many other excitable plants, exhibits that remarkable phenomenon which we commonly call the sleep of plants, that is, that as night approaches the leaf-stalks sink, and the leaflets fold up, the whole leaf assuming a position closely resembling that which it assumes when it is irritated. All that time will allow me to say on this subject is that although the leaf assumes the same position in sleep as after excitation, the two effects are not identical. The state of sleep differs from that in which the plant finds itself after it has been irritated in two particulars. The first is, that in the state of sleep it is still excitable, and responds to stimulation exactly in the same way, although from being already depressed the extent of its motion is diminished; the other is, that in sleep, the joint, although bent downwards, is still more or less resistent and elastic; whereas in the unexcitable (or, what comes to the same thing *excited*) state, all elasticity has disappeared. In a word, in the motor organ of Mimosa, in common with all other excitable structures, the characteristic of the excited state is *limpness*. All the Mimosa plants on the table are in the state of sleep, but are still excitable, for when they are touched they sink to an even lower position than that of sleep, and at the same time become limp. Hence you have, as the result of excitation, two changes, namely (1), the change of position, only to be observed when the plant is awake, and (2) the loss of stiffness, dependent, as we shall see, on a vital change in the protoplasm of the cells, which is also observed when the plant is asleep.

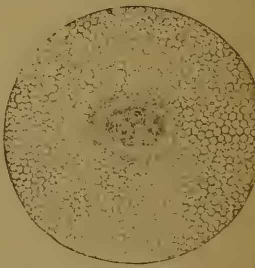


FIG. 2.—Section of the motor organ as projected on the screen. The vascular bundle in the middle of the section consists of a cylinder of thick-walled woody fibres and vessels, surrounded by a layer (annular in section) of elongated cells. The parenchyma is thicker below than above the vascular bundle. The section fails to show that the walls of the cells of the upper half have thicker walls.

So much for the general nature of the excitatory change. How do we discover what the mechanism is by which this remarkable organ of motion acts? By a mode of experiment which is well known to the physiologist. It may be called the method of ablation. We have here a mechanism which consists of several distinct parts, each, we may presume, having a distinct purpose; and the only method which will enable us to discover what these several purposes are is to observe how each acts alone—or, on the other hand, how the rest act after it has been taken away.

To prove that the motion of the whole leaf is dependent on the motor organ at the base of its stalk, requires no experiment. We see that the leaf descends, the joint bends, while the stalk remains rigid, and we know from its structure that the latter contains no mechanism by which it can act mechanically on the joint, as I act on my wrist by the muscles of my fore-arm.

The question therefore is—What part of the joint is essential? We begin by taking away the upper half, leaving the axial bundle and the lower half, and find that the leaf assumes a higher position than before. When touched, it falls. The function of the upper part, therefore, is merely auxiliary. The essential part is the lower, which in the unexcited state is capable of bearing the weight of the leaf. When it is excited it suddenly becomes weak, and the leaf falls. How does it do this? We will proceed to remove the axial bundle. The cellular cushion expands and lengthens, showing that it is elastic, and has a tendency to spring out when liberated. We have seen that this resistent cushion consists of cells, that is, of little

---

[1] Brücke, "Ueber die Bewegung der Mimosa pudica." Müller's "Archiv," 1848, p 434.

[1] Pfeffer, "Physiologische Untersuchungen," p. 9.

bladders, each of which is distended with liquid. And its tendency to expand as a whole is due to the tendency to expand of the innumerable cells of which it is made up. In the unmutilated state these are squeezed into a smaller space than that which they would assume if they were left to themselves; and, consequently, as their expansion is prevented, or curbed on one side, it acts on the opposite side, so as to bend the cylinder in the direction of the restraint.

All of this we can, perhaps, better understand by a model; and it is possible to make one which, not only in form but in principle, corresponds to the living mechanism it is intended to illustrate. In the model the axial bundle is represented by a strip of leather, the innumerable cells of the excitable cushion by an india-rubber bag. By a pump we are able to fill this cell or cushion more or less with fluid, and thus to vary its tension, and you see that if we increase the tension, the stem rises. By diminution it suddenly falls, just as the Mimosa leaf does when irritated.

We have come then to this point—that the reason why the leaf suddenly sinks on excitation is that the cells undergo a sudden diminution of tension or expansion. But our inquiry is not yet terminated. We have still to ask, How is this loss of tension effected? The answer is, by discharge of water. In the unexcited state all these cells are distended or charged with liquid. Suddenly, when the structure is excited, they let out or discharge that liquid, and it finds its way first into the intercellular air space, and secondly, out of the motor organ altogether. This we know to be a fact by an experiment of Pfeffer's, which must be regarded as one of the most important relating to the mechanism of plants that was ever made. He observed that if the leaf stalk is cut off from the motor organ, a drop of fluid appears at the cut surface at the moment that the latter bends downwards on excitation, and that in the experiment described just now, in which the upper part of the motor organ is cut off, there is also, so to speak, a sweating of liquid from the cut surface.

We are therefore certain that liquid escapes, but why does it escape? That I shall explain further on, and will now proceed to two other examples. One is a plant which is a great favourite in London, for it is one which flourishes even in London smoke—Mimulus. For our purpose it is good chiefly because its structure is very simple. It is one of those examples in which excitability is associated with the function of fertilisation, and inasmuch as this is a very transitory purpose, the property itself is transitory. When the cells of the stigmatic surface are touched they discharge their liquid contents, and consequently become limp. The outer layer of the lip is elastic, and tends to bend inwards. Consequently when the inner cells lose their elastic resilience it is able to act, and the lip bends inwards. In another allied plant, *Goldfussia anisophylla* (Fig. 3), which was described forty years ago by the Belgian naturalist Morren, we have the same mechanism. In this plant, as shown in the drawing, the style is not lipped but awl-shaped. It reaches to the mouth of the showy, orange-coloured corolla, to the inside of which it is united by its under surface. It has a smooth side, the epidermis of which is made up of numerous small prismatic cells, and is very elastic, and in the unexcited state concave, and a papillated side beset with the nipple-like ends of cylindrical cells, which, when unexcited, are distended with liquid. These cylindrical cells are continuous with those of the conducting tissue of the style. When an insect enters the flower, it does two things: it charges the fringe of hairs on the inside of the corolla with pollen, and touches the style, which, in consequence, bends suddenly in the opposite direction to that in which it was bent before, so as to plunge its stigmatic surface into the fringe. In this motion the epidermis acts as a spring simply. So long as the stigmatic tissue is turgid it cannot act. The moment its cells lose their tension, off it goes.[1]

Another plant investigated by Morren is one of very different organisation, but is one in which the existence of excitability has an equally plain teleological interpretation. Long ago Robert Brown, to whom plant-lore owes so much, when exploring the flora of Botany Bay, became acquainted with the now well-known Australian plant called Stylidium.[2] [A specimen from the Royal Gardens at Kew was exhibited.] Here is the plant (Fig. 4). The flower is too small to be easily seen, but the diagram will enable you to understand the mechanism. It has again to do with insects and fertilisation. In Stylidium the anthers and stigma are united together at the summit of a cylindrical stem which may be compared with the motor organ of Mimulus. You might naturally suppose that they were arranged so in order that the pollen from these anthers should be at once received by the adjoining stigmatic surface. That it is not so is evident from the order of development of the flower, for you find that at the moment that the anthers burst the stigma is not yet mature. Consequently the pollen is not intended for it, but for flowers which have come to maturity earlier, and the mechanism which now interests us fulfils this purpose. The figure shows the singular form of this strange flower. You observe that the column, as it is called, is bent down over the corolla so as to be in contact with the odd-looking labellum, which here takes the place of one of the petals. At the moment that the anthers burst the column attains its greatest sensitiveness. The slightest touch causes it to spring up, straighten itself suddenly, and then bend over to the opposite side. The mechanism resembles that of Mimosa and of Mimulus. There is a spring, the action of which is restrained by the resilience of cells distended with liquid. Suddenly these cells discharge their contents, and the spring acts.

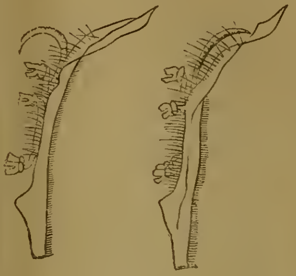


FIG. 3

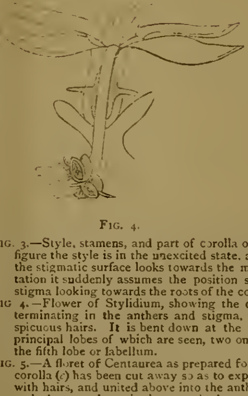


FIG. 4.

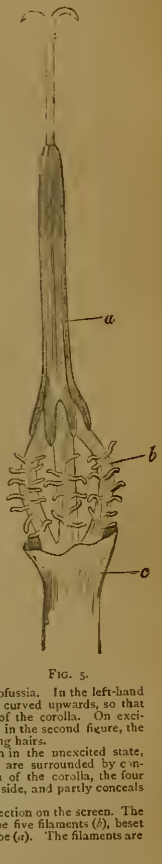


FIG. 5.

FIG. 3.—Style, stamens, and part of corolla of Golofussia. In the left-hand figure the style is in the unexcited state, and is curved upwards, so that the stigmatic surface looks towards the mouth of the corolla. On excitation it suddenly assumes the position shown in the second figure, the stigma looking towards the roots of the collecting hairs.

FIG 4.—Flower of Stylidium, showing the column in the unexcited state, terminating in the anthers and stigma, which are surrounded by conspicuous hairs. It is bent down at the mouth of the corolla, the four principal lobes of which are seen, two on each side, and partly conceals the fifth lobe or labellum.

FIG. 5.—A floret of Centaurea as prepared for projection on the screen. The corolla (*c*) has been cut away so as to expose the five filaments (*b*), beset with hairs, and united above into the anther tube (*a*). The filaments are arched outwards, as in the unexcited state.

And now let me pass to another group of plants which may serve as a contrast to Stylidium. Stylidium may be called an

---

[1] "Recherches sur le mouvement, &c., du style du Goldfussia anisophylla." *Mém. de l'Acad. Royale de Bruxelles.* 1839, vol. xii.

[2] Morren, "Recherches sur le mouvement et l'anatomie du *Stylidium graminifolium.*" *Mém. de l'Acad de Bruxelles*, t. xi., 1838.

out-of-the-way plant. It has an organisation which is not represented in the European flora. The family of thistles, and their allies the knapweeds (represented in our gardens by the ladies blue bottle), all of which are common wayside plants, exhibit excitable movements which, although of a very different kind from those we have just described, have, like them, to do with the visits of insects for the purpose of fertilisation. We will now throw on the screen a single fertile floret of *Centaurea Cyanus* (Fig. 5). The large diagram shows the same floret deprived of its corolla. Its axis is occupied by the style, surrounded by its tube of anthers. Below, the anther-filaments expand into a kind of cage, and again approach one another, when they are united with the tube of the corolla. At the moment that the anthers arrive at maturity these filaments are very excitable. When one of them is touched, it contracts and draws the style towards itself. Immediately afterwards the excitatory effect spreads to the others, all five arches becoming straight, and applying themselves closely to the style. A similar effect is produced by an induction shock. [The structure described was projected on the screen; on passing an induction current through it, the mode of contraction of the filaments was seen.]

The mechanism of Centaurea has been studied by many plant physiologists, particularly by Prof. Ferdinand Cohn of Breslau, and more recently with great completeness by Prof. Pfeffer. It has in this respect a greater interest than any other—that the shortening of these filaments in response to excitation strikingly resembles muscular contraction. You have here a structure in the form of a flattened cylinder which resembles many muscles in form, the length of which is diminished by about a sixth on excitation. This superficial resemblance between the two actions makes it the more easy to appreciate the differences.

Let me draw your attention to the diagram of an experiment made last year, which was intended to illustrate the nature of muscular contraction, and particularly to show that when a muscle contracts, it does not diminish in volume. The first difference between muscle and plant is a difference in the degree of shortening. A muscle shortens by something like a third of its length, the anther filament only by a sixth. But it is much more important to notice that in contracting, the filaments do not retain their volume. In shortening they broaden, but the broadening is scarcely measurable; hence they must necessarily diminish in bulk, and this shrinkage takes place, as Pfeffer has shown, exactly in the same manner as that in which the excitable cushion of Mimosa shrinks, namely by the discharge of liquid from its cells.

We are now in a position to study more closely the question to which I referred a few minutes ago—How do the cells discharge their contents? The structure of the filament of Centaurea, from its extreme simplicity, is a better subject of investigation with reference to this question, than any other. Each filament is a ribbon consisting of (1) a single fibro-vascular bundle, (2) delicate cells of regular cylindrical form, (3) an epidermis of somewhat thick-walled cells. [Microscopical preparations were shown.] In Mimosa we saw that the epidermis and vascular bundle took only a passive part in the production of the motion. Here, the part they play is even less important. Everything depends on the parenchyma, which, when excited, shrinks by discharging its water. Pfeffer proved this by cutting off the anther tube from the filaments, and then observing that on excitation a drop collected on the cut surface, which was reabsorbed as the filament again became arched. It is obvious that if the whole parenchyma discharges its liquid, each cell must do the same, for it is made up entirely of cells. To understand how each cell acts, we have only to consider its structure. Each consists of two parts—an external sac or vesicle, which is of cellulose, and, so long as the cell is in the natural or unexcited state, *over-distended*, so that, by virtue of its elasticity, it presses on the contents with considerable force; and secondly, of an internal more actively living membrane of protoplasm, of which the mechanical function is, so long as it is in its active condition, to charge itself fuller and fuller with liquid—the limit to further distension being the elastic envelope in which it is inclosed. In this way the two (the elastic envelope and the protoplasmic lining) are constantly in antagonism, the tendency of the former being towards discharge, that of the latter towards charge. This being so, our explanation of the effect of excitation on the individual cell amounts to this—that the envelope undergoes no change whatever, but that the protoplasm lining suddenly loses its water-absorbing power, so that the elastic force of the envelope at once comes into play and squeezes out the cell-contents. Consequently, although here, as everywhere, the protoplasm is the seat of the primary change, the mechanical agent of the motion is not the protoplasm, but the elastic envelope in which it is inclosed.

(*To be continued.*)

ELECTRIC LIGHTING BY INCANDESCENCE[1]

SPEAKING in this place on electric light, I can neither forget nor forbear to mention, as inseparably associated with the subject and with the Royal Institution, the familiar, illustrious, names of Davy and Faraday. It was in connection with this institution that, eighty years ago, the first electric light experiments were made by Davy, and it was also in connection with this Institution that, forty years later, the foundations of the methods, by means of which electric lighting has been made useful, were strongly laid by Faraday.

I do not propose to describe at any length the method of Davy, I must, however, describe it slightly, if only to make clear the difference between it and the newer method which I wish more particularly to bring under your notice.

The method of Davy consists, as almost all of you know, in producing electrically a stream of white-hot gas between two pieces of carbon.

When electric light is produced in this manner, the conditions which surround the process are such as render it impossible to obtain a small light with proportionally small expenditure of power. In order to sustain the arc in a state approaching stability, a high electromotive force and a strong current are necessary; in fact, such electromotive force and such current as correspond to the production of a luminous centre of at least several hundred candle-power. When an attempt is made to produce a smaller centre of light by the employment of a proportionally small amount of electrical energy, the mechanical difficulties of maintaining a stable arc, and the diminution in the amount of light (far beyond the diminished power employed), puts a stop to reduction at a point at which much too large a light is produced for common purposes.

The often-repeated question, "Will electricity supersede gas?" could be promptly answered if we were confined to this method of producing electric light; and for the simple reason that it is impossible, by this method, to produce individual lights of moderate power.

The electric arc does very well for street lighting, as you all know from what is to be seen in the City. It also does very well for the illumination of such large inclosed spaces as railway stations; but it is totally unsuited for domestic lighting, and for nine-tenths of the other purposes for which artificial light is required. If electricity is to compete successfully with gas in the general field of artificial lighting, it is necessary to find some other means of obtaining light through its agency than that with which we have hitherto been familiar. Our hope centres in the method—I will not say, the *new* method—but the method which until within the last few years has not been applied with entire success, but which, within a recent period, has been rendered perfectly practicable—I mean the method of producing light *by electrical incandescence*.

The fate of electricity as an agent for the production of artificial light in substitution for gas, depends greatly on the success or non-success of this method; for it is the only one yet discovered which adapts itself with anything like completeness to all the purposes for which artificial lighting is required.

If we are able to produce light *economically* through the medium of *electrical incandescence*, in small quantities, or in large quantities, as it may be required, and at a cost not exceeding the cost of the same amount of gas-light, then there can be little doubt—there can, I think, be *no* doubt—that in such a form, electric light has a great future before it. I propose, therefore, to explain the principle of this method of *lighting by incandescence* to show *how it can be applied*, and to discuss the question of *its cost*.

When an electrical current traverses a conducting wire, a certain amount of *resistance* is opposed to the passage of the current. One of the effects of this conflict of forces is the development of heat. The amount of heat so developed depends on the nature of the wire—on its length and thickness, and on the strength of the current which it carries. If the wire be thin and the current strong, the heat developed in it may be so great as to raise it to a white heat.

---

[1] Lecture delivered at the Royal Institution of Great Britain, March 10, 1882, by Joseph W. Swan, Sir Frederick Bramwell, F.R.S., vice-president, in the chair.

The experiment I have just shown illustrates the principle of electric lighting by incandescence, which is briefly this—that *a state of white heat may be produced in a continuous solid conductor by passing a sufficiently strong electrical current through it.*

A principle, the importance of which cannot well be overestimated, underlies this method of producing light electrically—namely, the principle of *divisibility.* By means of electric incandescence it is possible to produce exceedingly small centres of light, even so small as the light of a single candle; and with no greater expenditure of power in proportion to the light produced, than is involved in the maintenance of light-centres 10 or 100 times greater. Given a certain kind of wire, for example a platinum wire, the 100th of an inch in diameter, a certain quantity of current would make this wire white-hot whatever its length. If in one case the wire were one inch long and in another case ten inches long, the same current passing through these two pieces of similar wire, would heat both to precisely the same temperature. But in order to force the same current through the ten times longer piece, ten times the electromotive force, or, if I may be allowed the expression, electrical pressure, is required, and exactly ten times the amount of energy would be expended in producing this increased electro-motive force.

Considering, therefore, the proportion between power applied and light produced, there is neither gain nor loss in heating these different lengths of wire. In the case of the longer wire, as it had ten times the extent of surface, ten times more light was radiated from it than from the shorter wire, and that is exactly equivalent to the proportional amount of power absorbed. It is therefore evident that *whether a short piece of wire or a long piece is electrically heated, the amount of light produced is exactly proportional to the power expended in producing it.*

This is extremely important; for not only does it make it possible to produce a small light where a small light is required, without having to pay for it at a higher rate than for a larger light, but it gives also the great advantage of obtaining *equal distribution* of light. As the illuminating effect of light is inversely as the square of the distance of its source, it follows that where a large space is to be lighted, if the lighting is accomplished by means of centres of light of great power, a much larger total quantity of light has to be employed, in order to make the spaces remotest from these centres sufficiently light, than would be required if the illumination of the space were obtained by numerous smaller lights equally distributed.

In order to practically apply the principle of producing light by the incandescence of an electrically heated continuous solid conductor, it is necessary to select for the light-giving body a material which offers a considerable *resistance* to the passage of the electric current, and which is also capable of bearing an exceedingly high temperature without undergoing fusion or other change.

As an illustration of the difference that exists among different substances in respect of *resistance* to the flow of an electric current, and consequent tendency to become heated in the act of electrical transmission, here is a wire formed in alternate sections of platinum and silver; the wire is perfectly uniform in diameter, and when I pass an electric current through it, although the current is uniform in every part, yet, as you see, the wire is not uniformly hot, but white-hot only in parts. The white-hot sections are platinum, the dark sections are silver. Platinum offers a higher degree of resistance to the passage of the electric current than silver, and in consequence of this, more heat is developed in the platinum than in the silver sections.

The high electrical resistance of platinum, and its high melting-point, mark it out as one of the most likely of the metals to be useful in the construction of incandescent lamps. When platinum is mixed with 10 or 20 per cent. of iridium, an alloy is formed, which has a much higher melting-point than platinum; and many attempts have been made to employ this alloy in electric lamps. But these attempts have not been successful, chiefly because, high as is the melting-point of iridio-platinum, it is not high enough to allow of its being heated to a degree that would yield a sufficiently large return in light for energy expended. Before an economical temperature is reached, iridio-platinum wire slowly volatilises and breaks. This is a fatal fault, because *in obtaining light by incandescence there is the greatest imaginable advantage in being able to heat the incandescing body to an extremely high temperature.* I will illustrate this by experiment.

Here is a glass bulb containing a filament of carbon. When I pass through the filament *one unit* of current, light equal to *two candles* is produced. If now I increase the current by *one-half*, making it *one unit and a half*, the limit is increased to *thirty candles*, or thereabout, so that for this one-half increase of current (which involves nearly a *doubling of the energy* expended), *fifteen times more light* is produced.

It will readily be understood from what I have shown that it is essential to economy that the incandescing material should be able to bear an enormous temperature without fusion. We know of no metal that fulfils this requirement; but there is a non-metallic substance which does so in an eminent degree, and which also possesses another quality, that of *low conductivity.* The substance is carbon. In attempting to utilise carbon for the purpose in question, there are several serious practical difficulties to be overcome. There is, in the first place, the mechanical difficulty arising from its intractability. Carbon, as we commonly know it, is a brittle and non-elastic substance, possessing neither ductility nor plasticity to favour its being shaped suitably for use in an electric lamp. Yet, in order to render it serviceable for this purpose, it is necessary to form it into a slender filament, which must possess sufficient strength and elasticity to allow of its being firmly attached to conducting-wires, and to prevent its breaking. If heated white hot in the air, carbon burns away; and therefore means must be found for preventing its combustion. It must either be placed in an atmosphere of some inert gas or in a vacuum.

During the last forty years, spasmodic efforts have from time to time been made to grapple with the many difficulties which surround the use of carbon as the wick of an electric lamp. It is only within the last three or four years that these difficulties can be said to have been surmounted. It is now found that carbon can be produced in the form of straight or bent filaments of extreme thinness, and possessing a great degree of elasticity and strength. Such filaments can be produced in various ways—by the carbonisation of paper, thread, and fibrous woods and grasses. Excellent carbon filaments can be produced from the bamboo, and also from cotton thread treated with sulphuric acid. The sulphuric acid treatment effects a change in the cotton thread similar to that which is effected in paper in the process of making parchment paper. In carbonising these materials, it is of course necessary to preserve them from contact with the air. This is done by surrounding them with charcoal.

Here is an example of a carbon filament produced from parchmentised cotton thread. The filament is not more than the ·01 of an inch in diameter, and yet a length of three inches, having therefore a surface of nearly the one-tenth of an inch, gives a light of twenty candles when made incandescent to a moderate degree.

I have said, that, in order to preserve these slender carbon filaments from combustion, they must be placed in a vacuum; and experience has shown that if the filaments are to be durable, the vacuum must be exceptionally good. One of the chief causes of failure of the earlier attempts to utilise the incandescence of carbon, was the imperfection of the vacua in which the white-hot filaments were placed; and the success which has recently been obtained is in great measure due to the production of a better vacuum in the lamps.

In the primitive lamps, the glass shade or globe which enclosed the carbon filament was large, and usually had screw joints, with leather or india-rubber washers. The vacuum was made either by filling the lamp with mercury, and then running the mercury out so as to leave a vacuum like that at the upper end of a barometer, or the air was exhausted by a common air pump. The invention of the mercury pump by Dr. Sprengel, and the publication of the delicate and beautiful experiments of Mr. Crookes in connection with the radiometer, revealed the conditions under which a really high vacuum could be produced, and in fact gave quite a new meaning to the word vacuum. It was evident that the old incandescent lamp experiments had not been made under suitable conditions as to vacuum; and that before condemning the use of carbon, its durability in a really high vacuum required still to be tested. This idea having occurred to me, I communicated it to Mr. Stearn, who was working on the subject of high vacua, and asked his co-operation in a course of experiments having for their object to ascertain whether a carbon filament produced by the carbonisation of paper, and made incandescent in a high vacuum was durable. After much experimenting we arrived at the conclusion that *when a well-formed carbon filament is firmly connected with conducting wires, and placed in a hermeti-*

cally sealed glass ball, perfectly exhausted, the filament suffers no apparent change even when heated to an extreme degree of whiteness. This result was reached in 1878. It has since then become clearly evident that Mr. Edison had the same idea and reached the same conclusion as Mr. Stearn and myself.

A necessary condition of the higher vacuum was the simplification of the lamp. In its construction there must be as little as possible of *any* material, and there must be none of such material as could occlude gas, which being eventually given out would spoil the vacuum. There must besides be no joints except those made by the glass-blower.

Therefore, naturally and per force of circumstances, the incandescent carbon lamp took the most elementary form, resolving itself into a *simple bulb, pierced by two platinum wires supporting a filament of carbon.* Probably the first lamp, having this elementary character, ever publicly exhibited, was shown in operation at a meeting of the Literary and Philosophical Society of Newcastle in February, 1879. The vacuum had been produced by Mr. Stearn by means of an improved Sprengel pump of his invention.

Blackening of the lamp glass, and speedy breaking of the carbons, had been such invariable accompaniments of the old conditions of imperfect vacua, and of imperfect contact between carbon and conducting wires, as to have led to the conclusion that the carbon was volatilised. But under the new conditions these faults entirely disappeared; and carefully conducted experiments have shown that well-made lamps are quite serviceable after more than a thousand hours' continual use.

Here are some specimens of the latest and most perfected forms of lamp. The mode of attaching the filament to the conducting wires by means of a tiny tube of platinum, and also the improved form of the lamp, are due to the skill of Mr. Gimmingham.

The lamp is easily attached and detached from the socket which connects it with the conducting wires; and can be adapted to a great variety of fittings, and these may be provided with switches or taps for lighting or extinguishing the lamps. I have here a lamp fitted especially for use in mines. The current may be supplied either through main wires from a dynamo-electrical machine, with flexible branch wires to the lamp, or it may be fed by a set of portable store cells closely connected with it. I will give you an illustration of the *quality* of the light these incandescent lamps are capable of producing by turning the current from a Siemens' dynamo-electric machine (which is working by means of a gas engine in the basement of the building) through sixty lamps ranged round the front of the gallery and through six on the table. (The theatre was now completely illuminated by means of the lamps, the gas being turned off during the rest of the lecture.)

It is evident by the appearance of the flowers on the table that colours are seen very truly by this light, and this is suggestive of its suitability for the lighting of pictures.

The heat produced is comparatively very small; and of course there are no noxious vapours.

And now I may, I think, fairly say that the difficulties encountered in the construction of incandescent electric lamps have been completely conquered, and that their use is *economically practicable.* In making this statement I mean, that, both as regards the *cost of the lamp* itself and *the cost of supplying electricity to illuminate it,* light can be produced at a cost which will compare not unfavourably with the cost of gas light. It is evident that if this opinion can be sustained, lighting by electricity at once assumes a position of the widest public interest, and of the greatest economic importance; and in view of this, I may be permitted to enter with some detail into a consideration of the facts which support it.

There has now been sufficient experience in the manufacture of lamps to leave no doubt that they can be cheaply constructed, and we know by actual experiment that continuous heating to a fairly high degree of incandescence during 1200 hours does not destroy a well-made lamp. What the utmost limit of a lamp's life may be we really do not know. Probably it will be an ever-increasing span; as, with increasing experience, processes of manufacture are sure to become more and more perfect. Taking it, therefore, as fully established that *a cheap and durable lamp can now be made,* the further question is as to *the cost of the means of its illumination.*

This question in its simplest form is that of the more or less economical use of coal; for coal is the principal raw material alike in the production of gas and of electric light. In the one case, the coal is consumed in producing gas which is burnt; in the other in producing motive power, and, by its means, electricity.

The cost of producing light by means of electric incandescence may be compared with the cost of producing gas-light in this way—2 cwt. of coal produces 1000 cubic feet of gas, and this quantity of gas, of the quality called fifteen-candle gas, will produce 3000 candle-light for one hour. But besides the product of gas, the coal yields certain bye-products of almost equal value. I will, therefore, take it that we have in effect 1000 feet of gas from 1 cwt. of coal instead of from 2, as is actually the case.

And now, as regards the production of electricity. One cwt. of coal—that is the same measure *in point of value* as gives 1000 feet of gas—will give 50 horse-power for one hour. Repeated and reliable experiments show that we can obtain through the medium of incandescent lamps at least 200 candle-light per horse-power per hour. But as there is waste in the conversion of motive power into electricity, and also in the conducting-wires, let us make a liberal deduction of 25 per cent., and take only 150 candle-light as the nett available product of 1 horse-power; then for 50 horse-power (the product of 1 cwt. of coal), we have 7500 candle-light, as against 3000 candle-light from *an equivalent value* of gas. That is to say, two and a half times more light.

There still remains an allowance to be made to cover the cost of the renewal of lamps. There is a parallel expense in connection with gas lighting in the cost of the renewal of gas-burners, gas globes, gas chimnies, &c. I cannot say that I think these charges against gas-lighting will equal the corresponding charges against electric lighting, unless we import into the account—as I think it right to do—the consideration that, without a good deal of expense be incurred in the renewal of burners, and unless minute attention be given, far beyond what is actually given, to all the conditions under which the gas is burned, nothing like the full light product which I have allowed to be obtainable from the burning of 1000 cubic feet of gas, will be obtained, and, as a matter of fact, is not commonly obtained, especially in domestic lighting. Taking this into account, and considering what would have to be done to obtain the full yield of light from gas, and that if it be not done, then the estimate I have made is too favourable, I think but little, if any, greater allowance need be made for the charge in connection with the renewal of lamps in electric lighting than ought to be made for the corresponding charges for the renewal of gas-burners, globes, chimneys, &c. But it will be seen that even if the cost for renewal of lamps should prove to be considerably greater than the corresponding expense in the case of gas, there is a wide margin to meet them before we have reached the limit of the cost of gas-lighting.

I think too it must be fairly taken into account and placed to the credit of electric lighting, that by this mode of lighting there is entire avoidance of the damage to furnishings and decorations of houses, to books, pictures, and to goods in shops, which is caused through lighting by gas, and which entails a large expenditure for repair, and a large amount of loss which is irreparable.

I have based these computations of cost of electric light on the supposition that the light product of 1 horse-power is 150 candles. But if durability of the lamps had not to be considered, and it were an abstract question how much light can be obtained through the medium of an incandescent filament of carbon, then one might, without deviating from ascertained fact, have spoken of a very much larger amount of light as obtainable by this expenditure of motive power. I might have assumed double or even more than double the light for this expenditure. Certainly double and treble the result I have supposed can actually be obtained. The figures I have taken are those which consist with long life to the lamps. If we take more light for a given expenditure of power, we shall have to renew the lamps oftener, and so what we gain in one way we lose in another. But it is extremely probable that a higher degree of incandescence than that on which I have based my calculations of cost, may prove to be compatible with durability of the lamps. In that case, the economy of electric lighting will be greater than I have stated.

In comparing the cost of producing light by gas and by electricity, I have only dealt with the radical item of coal in both cases. Gas-lighting is entirely dependent upon coal—electric lighting is not, but in all probability coal will be the chief source of energy in the electric lighting also. When, however, water power is available, electric lighting is in a position of still greater advantage, and, in point of cost, altogether beyond comparison with other means of producing light.

To complete the comparison between the cost of electric light and gas light, we must consider not only the amount of coal required to yield a certain product of light in the one case and in the other, but also the cost of converting the coal into electric current and into gas; that is to say, the cost of manufacture of electricity and the cost of manufacture of gas. I cannot speak with the same exactness of detail on this point as I did on the comparative cost of the raw material. But if you consider the nature of the process of gas manufacture, and that it is a process, in so far as the lifting of coal by manual labour is concerned, not very unlike the stoking of a steam boiler, and if electricity is generated by means of steam, then the manual labour chiefly involved in both processes is not unlike. It is evident that in gas manufacture it would be necessary to shovel into the furnaces and retorts five or six times as much coal to yield the same light product as would be obtainable through the steam engine and incandescent lamps. But here again it is necessary to allow for the value of the labour in connection with the products other than gas, and hence it is right to cut down the difference I have mentioned to half—*i.e.* debit gas with only half the cost of manufacture, in the same way as in our calculation we have charged gas with only one-half the coal actually used. But when that is done there is still a difference of probably three to one in respect of labour in favour of electric lighting.

I have made these large allowances of material and labour in favour of the cost of gas, but it is well known that the bye products are but rarely of the value I have assumed. I desire, however, to allow all that can be claimed for gas.

With regard to the COST OF PLANT, I think there will be a more even balance in the two cases. In a gasworks you have retorts and furnaces, purifying chambers and gasometers, engines, boilers, and appliances for distributing the gas and regulating its pressure. Plant for generating electricity on a large scale would consist principally of boilers, steam-engines, dynamo-electric machines, and batteries for storage.

No such electrical station, on the scale and in the complete form I am supposing, has yet been put into actual operation; but several small stations for the manufacture of electricity already exist in England, and a large station designed by Mr. Edison is, if I am rightly informed, almost completed in America. We are therefore on the point of ascertaining by actual experience, what the *cost of the works* for generating electricity will be. Meanwhile, we know precisely the cost of boilers and engines, and we know approximately what ought to be the cost of dynamo-electric machines of suitably large size. We have, therefore, sufficient grounds for concluding that to produce a given quantity of light electrically the cost of plant would not exceed greatly, if at all, the cost of equivalent gas-plant.

There remains to be considered, in connection with this part of the subject, the *cost of distribution*. Can electricity be distributed as widely and cheaply as gas? On one condition, which I fully hope can be complied with, this may be answered in the affirmative. The condition is that it may be found practicable and safe to distribute electricity of comparatively high tension.

The importance of this condition will be understood when it is remembered that to effectively utilise electricity in the production of light in the manner I have been explaining, it is necessary that the *resistance in the carbon of the lamps* should be relatively great to the *resistance in the wires which convey the current to them*. When lamps are so united with the conducting wire, that the current which it conveys is divided amongst them, you have a condition of things in which the aggregate resistance of the lamps will be very small, and the conducting wire, to have a relatively small resistance, must either be *very short*, or, if it be long, it must be *very thick*, otherwise there will be excessive waste of energy; in fact, it will not be a practical condition of things.

In order to supply the current to the lamps economically, there should be comparatively little resistance in the line. A waste of energy through the resistance of the wire of 10 or perhaps 20 per cent. might be allowable, but if the current is supplied to the lamps in the manner I have described—that of *multiple arc*, each lamp being as it were *a crossing between two main wires*, then—and even if the individual lamps offered a somewhat higher degree of resistance than the lamps now in actual use—the thickness of the conductor would become excessive if the line was far extended. In a line of half a mile, for instance, the weight of copper in the conductor would become so great, in proportion to the number of lamps supplied through it, as to be a serious charge on the light. On the other hand, if a smaller conducting wire were used, the waste of energy and consequent cost would greatly exceed that I have mentioned as the permissive limit.

Distribution in this manner has the merit of simplicity, it involves no danger to life from accidental shock; and it does not demand great care in the insulation of the conductor. But it has the great defect of limiting within comparatively small bounds the area over which the power for lighting could be distributed from one centre. In order to light a large town electrically on this system, it would be necessary to have a number of supply stations, perhaps half a mile or a mile apart. It is evidently desirable to be able to effect a wider distribution than this, and I hope that either by arranging the lamps *in series*, so that the same current passes through several lamps in succession, or by means of *secondary voltaic cells*, placed as electric reservoirs in each house, it may be possible to economically obtain a much wider distribution.

Whether by the method of multiple arc (illustrated by Diagram I.) which necessitates the multiplication of electrical stations; or by means of the simple series (illustrated by Diagram II.), or by means of secondary batteries connected with each other from house to house in single series, the lamps being fed from these in multiple arc (as illustrated by Diagram III.), I am quite satisfied that comparatively with the distribution of gas, the distribution of electricity is sufficiently economical to permit of its practical application on a large scale.

As to the cost of laying wires in a house, I have it on the authority of Sir Wm. Thomson, who has just had his house completely fitted with incandescent lamps from attics to cellars—to the entire banishment of gas—that the cost of internal wires for the electric lamps is less than the cost of plumbing in connection with gas-pipes.

I have expended an amount of time on the question of *cost* which I fear must have been tedious; but I have done so from the conviction that the practical interest of the matter depends on this point. If electric lighting by incandescence is not an economical process, it is unimportant; but if it can be established—and I have no doubt that it can—that this mode of producing light is economical, the subject assumes an aspect of the greatest importance.

Although at the present moment there may be deficiencies in the apparatus for generating and storing electricity on a very large scale, and but little experience in distributing it for lighting purposes over wide areas, and consequently much yet to be learnt in these respects; yet, if once it can be clearly established that, light for light, electricity is as cheap as gas, and that it can be made applicable to all the purposes for which artificial light is required, electric light possesses such marked advantages in connection with health, with the preservation of property, and in respect of safety, as to leave it as nearly certain as anything in this world can be, that the wide substitution of the one form of light for the other is only a question of time.

SCIENTIFIC SERIALS

Bulletin de l'Academie Royale des Sciences de Belgique, No. 6.—Resistance of the air in guns; letter by M. Colladon.—Note on experimental ballistics, by M. Melsens.—Experimental rerearches on the respiratory movements of insects, by M. Plateau.—Existence and amount of diurnal precession and nutation, on the hypothesis of a solid earth, by M. Folie.—Fundamental principle relative to contact of two surfaces having a common generatrix, by M. Mansion.—On a geometrical representation of two uniform transformations, by M. Le Paige.—On bibrominated camphor, by M. Swarts.—Action of trichloride and tribromide of phosphorus on gaseous phosphuretted hydrogen, by M. de Wilde.—Action of trichloride of phosphorus on iodide of phosphonium, by the same.—Researches on the structure and signification of the respiratory apparatus of Arachnida, by Mr. MacLeod.

Annalen der Physik und Chemie, No. 8.—On development of electricity as equivalent of chemical processes, by F. Braun.—The theory of the micro-telephone, by V. Wietlisbach.—On prism-observation with obliquely-incident light, and on a modification of the Wollaston method of determination for relations of light-refraction, by F. Kohlrausch.—On the setting of an object in the total-reflectometer, by the same.—On the tensions of saturated mercury-vapour at low temperatures, by E. B. Hagen.—On determination of the constants of internal friction of gases and liquids, by means of oscillating discs, by L. Grossmann.—Determination of the friction of liquids by Maxwell's method, by Th. S. Schmidt.—Researches on the volume-constitution of liquid compounds, by H. Schröder.—On the phosphates of thallium and lithium, by C. Rammelsberg.—On potassium-dithallium-chloride, by the same.—On the electricity of flames (corrections), by J. Elster and H. Geitel.

Atti della R. Accademia dei Lincei. Transunti, vol. vi. fasc. 13.—On Italian emigration in 1881 compared with that of the five previous years, and with the emigration from other States of Europe, by S. Bodie.

SOCIETIES AND ACADEMIES

London

Royal Horticultural Society, July 25.—Sir J. D. Hooker in the chair.—*Hybrid Tacsonia:* Dr. Masters exhibited a blossom of a hybrid between *T. exoniensis* (itself a hybrid) and *Vochsiemi.*—*Rhododendron camellii florum :* Mr. Mangles exhibited a spray of this late-flowering species, which resembled a tea in flower. It bore only one flower instead of two together, as described by Hooker; and he suggested it might be identical with *R. sparsiflorum*, Booth, of Bhotan. In foliage it agrees with *R. Maddeni.*—*Hollyhock disease:* Mr. W. G. Smith gave an account of his planting healthy seeds of the hollyhock and others affected with Puccinia. He planted twenty tainted seeds, one of two only which germinated, survived. This one appears to be quite unaffected. Of fifty healthy seeds, all germinated. After the third week, leaves of common mallow diseased with Puccinia were scattered amongst them. In less than a week forty-six of the seedlings died of the disease.—*Rhododendron hybrids:* Mr. Veitch sent blossoms of seedlings of a hybrid, to show interesting deviations, a slightly double flower having been artificially "self-fertilised," twenty seedlings were raised from it. Of these five have blossomed, as follows: a deep rose, a double white, a semi-double yellow, a salmon, and a semi-double rose. The remarkable features about them are that white crossed by orange gives pink, the yellow being eliminated, and that a rudimentary calyx appears on these seedlings, *R. Jasminiflorum*, one of the original parents, having none.—Mr. Henslow remarked on the general tendency to suppress a calyx in flowers, which are small and massed together, as in Rubiaceæ, Caprifoliaceæ, Umbelliferæ, &c., and suggested that its re-appearance was correlated to the enlarged corolla, and less "massing" of the truss than occurs in *R. Jasminiflorum.*

Paris

Academy of Sciences, July 31.—M. Jamin in the chair.—The following papers were read:—On the period of variable state which precedes the *régime* of detonation, and on the conditions of establishment of the explosive wave, by MM. Berthelot and Vieille. They recorded on a rotating cylinder, the spark causing the initial inflammation at the entrance of the tube, and the displacement of a very light piston moving freely in the tube at the other end. They study the velocities, the corresponding pressures, and the limits of detonation.—Additional note on the rapid solution of the problem of Kepler, by M. Zenger.—Auxiliary tables for calculating the true anomaly of planets, by the same.—On some theorems of electricity, demonstrated in an inexact way in didactic works, by M. Machai.—On the longitudinal vibrations of elastic wires whose ends are submitted to any strains, by MM. Sebert and Hugoniot.—On the electric resistance ot glass at low temperatures, by M. Foussereau. Using ordinary glass with base of soda and lime, Bohemian glass and crystal, the electric conductivity was found to rise rapidly with the temperature. The method is described, and formulæ are given.—On the flow of sound in pipes, by M. Neyreneuf. With a sensitive flame, from a burner like the Bunsen, but having, instead of the lower air holes, one small lateral orifice at about two-thirds of the height, he measured the intensity of a sound (from strokes of a bell) that had traversed tubes of different length and diameter, watching at what distance from the mouth of the tube the flame became insensible. He obtains a formula representing the law.—On the heat of dissolution of some mixtures, by M. Chroustchoff.—Action of ammonia on oxide of copper, by M. Maumené.—On the composition of *vins de marc*, by M. Girard. This name he applies to wines from fermentation of sugar in presence of the residua of vintage. He says they have a pretty regular composition, and have alimentary and hygienic qualities equivalent to two-thirds to half those of ordinary wines.—On the ethers of glycol, $C_{22}H_{14}O_2$, by M. Rousseau.—Preparations of acetylcyanacetic ether and some of its metallic derivatives, by MM. Haller and Held.—On the conditions of formation of rosanilines, by MM. Rosenstiehl and Gerber.—On a new use of electrolysis in dyeing and printing, by M. Goppelsrœder. For example, he impregnates tissues or paper with an aqueous solution of chlorhydrate of aniline, puts it on a non-attackable metal plate, which he connects with one pole of a battery or small dynamo. On the tissue or paper is placed a second metal plate having a design in relief and joined to the other pole; on pressure and passage of the current the design is reproduced. A modification of the method gives chemical discharge of colour. The current, again, is used to prepare vats of indigo, aniline black, &c.; the hydrogen which arises at the negative pole being utilised. It is also used to prevent oxidation of colours in printing.—On the formation and decomposition of acetanilide, by M. Menschutkin.—On the products of distillation of colophany, by M. Renard.—On *Crenothrix Kühniana* (Rabenhorst), cause of infection of the waters of Lille, by M. Giard. This gives an iron red scum in the water of the Emmerin springs supplying the town. The evil has been very pronounced this spring. Rains bring it on; engaging these small organisms, that quickly develop in the moist earth prepared by dejections from distilleries, &c.—Structure of the nervous systems of molluscs, by M. Viguel.—On the male sexual organs and the Cuvier organs of Holothurians, by M. Jourdain.—Researches on the production of monstres, in the hen's egg, by means of slow incubation, by M. Dareste.—On sexuality in the ordinary system (*O. Edulis*), and in the Portuguese system (*O. Angulata*); Artificial fecundation of the latter, by M. Bouchon-Brandely.—On the properties of antiseptics, and volatile products of putrefaction, by M. Le Bon. The disinfectant power of any antiseptic is weaker the older the putrefaction. The strongest disinfectants are permanganate of potash, chloride of lime, sulphate of iron acidified with acetic acid, carbolic acid, and the glyceroborates of sodium and potassium. There is no parallelism between disinfectant action of an antiseptic and its action on microbes; nor between the power of preventing putrefaction and that of stopping it when it has begun. Except a very few substances, strongly poisonous (such as bichloride of mercury), most antiseptics, and notably carbolic acid, have very little action on bacteria. There is no parallelism between the virulent power of a substance in putrefaction and the toxical power of volatile compounds liberated from it. The volatile alkaloids from advanced putrefaction are very poisonous. The air of cemeteries may be very dangerous.—On an observation of diffuse lightning, by M. Rousseau.

CONTENTS

THURSDAY, AUGUST 17, 1882

THE LIFE OF IMMANUEL KANT

The Life of Immanuel Kant. By J. H. W. Stuckenberg, D.D., late Professor in Wittenberg College, Ohio. (London: Macmillan and Co., 1882.)

IN a former number occasion was taken—in connection with a review of Prof. Max Müller's translation of the "Kritik der reinen Vernunft"—to examine at some length the position of Kant's theory of experience in relation to scientific method.

Dr. Stuckenberg's book is of an order different from that of Prof. Max Müller's book. It has no pretensions to brilliance, nor does it attempt to reproduce the system of the thinker whose life forms its subject. It is a plain book, written for such plain people as are content to hear what sort of man Kant was without learning much of his teaching. But its plainness notwithstanding, it is a very useful work, abounding as it does in facts and common sense. No one can read it and continue to go about his business with the old impression that Kant was a metaphysical dreamer of that *a priori* school which found its apotheosis in Hegel as popularly conceived. We learn from Dr. Stuckenberg's pages, what ought to be much better understood than is currently the case, that Kant was an inquirer into the facts of nature, who was forced by the difficulties which presented themselves in his generalisations to investigate the constitution of experience itself. And we have material sufficient to enable us to gather that Kant's method in his criticism of knowledge was precisely the same as his method in his earlier criticism of nature. It is perhaps not to be wondered at that philosophy should since 1848 have fallen into bad repute. But it is to be wondered at, that with two or three exceptions, the English exponents of the sort of philosophy which is most in favour among educated men in this country, should know so little about the teaching of the great successor of Hume, a teacher whose criticisms have a greater and more important bearing upon the question of method than have those of Hume himself.

Apart from his work in philosophy and in mathematical physics and astronomy, the life of Kant is of peculiar interest in itself. He contributed largely to the bringing about of that revolution in literature which was carried to its consequences by Herder and Lessing, and which culminated in Goethe. He probably did more than any other man—even than Goethe—to give to Germany the intellectual position which she held in the early years of this century. But just because Kant's work was never of an order readily intelligible to ordinarily educated men, he remains to this day for the most part merely a great personality about whose thoughts little is known. What Kant was, as distinguished from what he did, will at least be collected from the pages of Dr. Stuckenberg.

It is open to doubt whether there is any idea about which educated people deceive themselves more than the supposed distinction between the "high *a priori*" method of philosophy and the experimental method of science. The methods of science and philosophy are really indistinguishable. They consist simply in the application of a previously conceived hypothesis to a given state of facts and the acceptation or rejection of the hypothesis according as it is or is not in harmony with these facts and adequate to their explanation. The exact sciences are distinguished from other sciences by the possibility of determining in their examples the question of harmony and adequacy in part at least by measurement. But there is much that comes properly within the description of science that is not exact science. Much of the body of doctrine which for example constitutes the science of biology cannot be tested by measurement, and hardly any of the conceptions of such branches of knowledge as philology or political economy can be so verified. If with Kant we look on philosophy as the science of knowledge itself as distinguished from its objects, and in this light examine the history of modern thought since his time, we find a conception of the nature of experience gradually evolved and developed by precisely the same process as in the case of the sciences—exact and otherwise. To understand how the idea of a difference in method sprang up it is necessary to go back to the pre-Kantian philosophers. Then there certainly did exist (just as there have existed in recent times) an almost universal belief (dissented from by Locke and his successors in England) that it was possible to deduce the nature of things by *a priori* reasoning from principles. And this belief was entertained by men of science almost as widely as by metaphysicians. Kant finally did for philosophy what Bacon did for science, and a careful consideration of the aberrations of some of his true successors show that however much they may have drifted into eccentricities they never lost sight of the new departure. No one for example who has given attention to the "Naturphilosophie" of Hegel supposes that Hegel meant to "deduce" Nature, or that he is dealing with anything else than the application of his fundamental conceptions to a certain phase of the problem of the constitution of knowledge. And yet not a few eminent critics have mistaken Hegelian irony for serious earnest. The time has come for recognising the fact that the rejection of the philosophical method, if it means anything at all, means the rejection of all that in science is not capable of reduction to space measurement, and men of science would do well to try to find out how much is implied in such a rejection. For such a purpose nothing is so well adapted as the study of Kant's works. Kant was a man of science who came ultimately to philosophy as a form of science. And for him the main feature of philosophy was that it purged the special sciences of a vast quantity of bad metaphysics, of unconscious assumptions which have been the real reason of those ultimate contradictions in their conceptions, which in modern times have proved so great a difficulty to the most acute investigators. It was not until middle age that he turned his attention to difficulties which had been forced upon his notice in the course of his researches in mathematical physics and biology.

One of the main lessons to be learned from Kant is the necessity of extreme caution in the formulation of the terms of all general problems. No one who has carefully studied Kant is likely to speak of the transition from the region of mechanism into that of organisation, or of the physical atom as conceivable objects of experience. Still less is he likely to reason about mind as though it were a form of energy, a substance or a thing. He will find himself approaching the consideration of all such problems with a new light and an increasing disposition to limit the field of inquiry. He will also see that much that he took to relate to problems of the nature of objects within experience, really relates to the problem of experience itself. And he will probably agree with Kant in thinking that the difficulty of investigating this special problem is a difficulty not of kind but of degree, and this whether his conclusions are those of Kant or none at all. Just at present, when the tendencies of science are increasingly in the direction of general conceptions, it is difficult to avoid feeling that some knowledge of what Kant really taught ought to be far more widely diffused among scientific men than is actually the case.

R. B. HALDANE

RECENT ORNITHOLOGICAL LITERATURE

The Coues Check List of North American Birds. Second Edition, Revised to Date, and entirely Rewritten, under direction of the Author, with a Dictionary of the Etymology, Orthography, and Orthoepy of the Scientific Names, the Concordance of Previous Lists, and a Catalogue of his Ornithological Publications. 8vo, pp. 1-165. (Boston: Estes and Lauriat, 1882.)

Beiträge zur Ornithologie Südafrikas. Von Dr. Emil Holub and Aug. von Pelzeln. (Wien: Hölder, 1882.)

DR. ELLIOTT COUES is well known for the laborious works on ornithological literature which have flowed from his pen during the last ten years. No fact seems too trivial for record, no labour too great for this author when once he sets his mind to exhaust the literary history of any group of birds, or the ornithological fauna of a country. We have just received a copy of his second Check List of North American Birds, which appears to us to be much the most complete work of its kind which has yet appeared. An entire list of the Birds of North America, as politically defined, is here given, and we perceive that the number of recorded species has increased from 283 in 1814 (Wilson) to 888 in the present volume. Mr. Ridgway's estimate in 1880 was 924, but this total is reached by including in the North American List several species which are found in Mexico, as well as in the islands of Socorro and Guadeloupe. Dr. Coues considers that there are not more than thirty out of his 888 species "whose claims to be recognised by sub-specific names can be seriously questioned. Pp. 1-22 are occupied with the Introduction, a comparison of the present edition with the former Check List published in 1874, and a very interesting treatise on the "Use of Names." American ornithologists have so long ago adopted the trinomial system of nomenclature that it has become part and parcel of their writings, but so far it has not been adopted by Old World ornithologists, at least in the same sense as that in which the Americans employ the three names. To have to label a specimen *Icterus melanocephalus auduboni* (Gir.), Coues, is certainly more awkward than simply writing *Icterus auduboni*, and if the race is not worthy of a separate name it would seem better to suppress it altogether, and to quote the species as *Icterus melanocephalus*. The system too appears to us likely to bolster up sub-species and races which are not entitled to such recognition, as, for instance, in the case of the common Barn-Owl (*Aluco flammeus pratincola*), and the Magpie (*Pica rustica hudsonica*), which are not distinguishable even as sub-species from the European *Aluco* (*potius Strix*) *flammeus*, and *Pica rustica*, but seem to be retained by American authors under their system of trinomial nomenclature, chiefly because they have been once separated and have been called *Aluco pratincola* and *Pica hudsonica*. The Yellow-billed Magpie of California is placed upon the same footing as *Pica hudsonica*, and receives the trinomial epithet of *Pica rustica nuttalli*, whereas we have never yet seen proof of any gradation between it and *Pica rustica*, so that it would appear to be quite a good species, and entitled to full specific rank. These are small points on which European ornithologists are always likely to differ from their American brethren, but there can only be one opinion about the great value of the etymological portion of the present work, which has been most carefully written by Dr. Coues, the classical derivation of every generic and every specific name being most carefully given; and in this portion of his task the author acknowledges the obligations which he is under to Mrs. S. Olivia Weston-Aiken, "who cordially shared with him the labour of the philological investigation."

We are pleased to see that several etymological corrections recently set forward by Mr. Henry Wharton are adopted by Dr. Coues, who handsomely acknowledges the assistance given by Mr. Wharton. The latter gentleman is well-known in this country for his researches into the classical derivation of the names of birds, and he is now Secretary to a Committee of the British Ornithologists' Union, which is shortly about to issue a standard list of British Birds, in which special attention will be paid to the etymology of the names.

We have also on our table an account of the Ornithological Results of Dr. Holub's explorations in Southern Africa, written by the traveller himself, assisted by Herr von Pelzeln, of the Vienna Museum. This book contains a large number of illustrations, representative of bird-life in Southern Africa, the woodcuts being so well executed that we are able to gain a good idea of the nesting, habits, and economy of many South African species in their native haunts. Excellent accounts of the habits, especially of the breeding of a great number of species are given, and ostrich-farmers will find much that will interest them in the account of the South African ostrich. Several anatomical notes are dispersed throughout the volume, and many good figures of skeletons are given, including two plates devoted to the tongues of birds. Of the new species figured *Drymoica holubi* (Taf. I.) is scarcely likely to be really undescribed amongst the numerous *Cisticolæ* of Southern Africa, and *Lanius pyrrhostictus* (Taf. II.) is certainly only the female of *L. collaris*. All such works as Dr. Holub's add much to our knowledge of the geographical distribution of birds, especially when, as in the present instance, they are accompanied by a good map showing the country in which the collection was made.

Capt. Blakiston and Mr. H. Pryer have just issued a revised list of the "Birds of Japan," and it forms a most useful epitome of our present knowledge of the ornithology of this interesting country. Three hundred and twenty-six species are enumerated, notes being given on their geographical distribution in the different islands of Japan, and it would appear from the frequent mention of different museums that the Japanese have adopted this mode of education along with their other advances in civilisation. One of the most interesting features of the present list is the additional knowledge acquired by Mr. Snow's visit to the Kuril Islands, which locality, however, does not seem to be very rich in land-birds, though many wading-birds—gulls and petrels—appear to have been noticed. The authors have carefully identified all the species which have come under their notice, and in doubtful cases have forwarded specimens to England for comparison, so that little fault can be found with the present list, which seems to be the result of much good sound work, and we congratulate the authors on having placed the ornithology of Japan on such a satisfactory footing. A comparison of some of the smaller owls with the type specimens in the British Museum would appear desirable, and we have no doubt that Mr. Bowdler Sharpe would assist the authors, if specimens were forwarded to him for identification.

ICELAND

Summer Travelling in Iceland. By John Coles, F.R.A.S. (London: Murray, 1882.)

By Fell and Fjord. By E. G. Oswald. (London: Blackwood, 1882.)

THE most prominent—we ought perhaps to say, the one redeeming—feature of Mr. Coles's work is the fact that he occupied himself by taking observations of heights, temperatures, distances, and magnetic variations while travelling in Iceland. This is rarely done because of the difficulty of carrying instruments over a very rough, and in some places pathless, country. The result has been that the map appended to "Summer Travelling" is perhaps the most accurate which has yet appeared. Mount Paul, and a few more-familiar names, are strangely enough not inserted, but, on the other hand, the heights of the principal mountains and highlands are given in English feet; the crater of Askja is shown of its proper form; and the details of the Sprengisandr route are mapped. At the same time, the map is not so *clear* as that of Gunnlaugsson, who was careful to indicate the different surface soils—lava, sand, heath, &c.—by differences both of shading and of colour. If those who travel in a little-known country would provide themselves with a good aneroid, compass, and thermometer, and would learn before starting how to use them, and maintain a habit of using them constantly while on their travels, like Mr. Coles, it would be to the great advantage of science.

According to Mr. Coles, the magnetic variation in the extreme west of Iceland is 43° W., while on the east coast it is 34° W., and the compass error in different parts of the islands will thus vary by three-quarters of a point. Thus in the W. of the island the compass box must be turned until the N. end of the magnetic needle is over N.W., while in the E. of the island the N. end would require to be placed over N.W. by N., and then all the points marked on the card would indicate true bearings.

We may mention also a capital plan of the Haukadalr Geysirs, better, we believe, than any one which has appeared since that of Baring Gould.

Apart from the observations, the book contains nothing which is new to Icelandic travellers, or to those acquainted with the literature relating to travel in that country. The description of the Thingvellir-Geysir-Hekla-Krisuvik route, is as old as the hills, and becomes infinitely wearisome from much repetition. Four chapters out of eleven take us only as far as Hekla, and then the author did not ascend it. The journey across the Sprengisandr was quite uneventful, and the detour to Askja was without interest—that is, it did not bring to light any facts not previously observed by Prof. Johnstrup, Lieut. Maroc, or Mr. W. G. Lock. Also when we read that "Summer Travelling in Iceland" is a "narrative of two journeys across the island by unfrequented routes," we are disappointed to find the less frequented route without any interest, and the other by no means "unfrequented," but in fact the ordinary mail route between Akureyri and Reykjavik.

During the last twenty years books on Iceland have multiplied too rapidly, and there is no need for another work on the subject, unless it deals with some special features of the country scientifically, or unless it is a record of exploration, like plucky Mr. Watts's record of a journey "Across the Vatna Jökull." If somebody will further explore this tract of unknown country larger than Lincolnshire, or ascend and measure virgin peaks, or trace the lava streams of Koëtla to their source, or minutely survey the Krafla district, we shall welcome their records with open arms.

"By Fell and Fjord" is a bright, pleasantly written book, by a lady who has visited Iceland three times, has travelled over some of the less frequented paths, and has entered with wonderful spirit into the nature of the weird volcanic surroundings, and the tone and temper of the people, the language, and the literature. Miss Oswald is so fond of everything connected with the island, that she has braved discomforts which few ladies would willingly face. Her bravery impresses us immensely: she never feared to ford the most dangerous glacier river, never quaked while crossing the most treacherous bog, and was never discouraged by misfortunes caused by bad weather or a mistaken route. And then she is genuinely enthusiastic about the scenery, the wild gipsy life, and the cordial kindly people. G. F. RODWELL

OUR BOOK SHELF

Madeira: its Scenery, and How to see it. (London: Stanford, 1882).

A USEFUL handbook to Madeira has just been published by Messrs. Stanford. It can hardly lay claim to be a scientific work, yet a fair knowledge of botany and kindred subjects is pre-supposed to exist by its author, Miss Ellen Taylor, and much of the interest in the excursions detailed is due to the introduction of this element. It presents, in fact, a very marked improvement over ordinary handbooks, and the treatment of the natural history section is excellent.

There is little of history to relate, and even the discovery of the island, which took place as recently as the early part of the fifteenth century, is involved in some obscurity. The race is mixed, and the aristocracy at least seems to have been recruited from Italy, France, and Flanders. The island is entirely volcanic, and no rocks earlier than Miocene exist in it. When volcanic action ceased is unknown, but even the most recent lavas seem to have suffered great denudation—no vapours are now exhaled—and the island is profoundly quiescent save from occasional earthquakes, as in 1748. The vast majority of visitors gather their impressions of Madeira from a limited halt in the Bay of Funchal, or from a winter sojourn on its south side, yet fine as its coast line and peaks are seen to be, they are no more comparable to the grandeur of the northern side than the cultivated banks of the Rhine are to the gorges of the Yosemite. The south side is almost destitute of forest growth, except the introduced sweet chestnut, oak, and maritime pine, for the native juniper and dragon trees are almost extinct, but in crossing the dividing ridge another world is entered. Here all but the highest peaks are clothed with densest virgin forest. The naturalist may penetrate at will the wildest gorges, for the only paths into their recesses are the beds of half dried torrents.

The common distinctive feature of all these gorges is the precipitous nature of their sides, which time seems not yet to have weathered into angles of repose. The verticality is everywhere appalling, yet giant evergreens cling to every nook and crowd on every terrace. Some of the laurel tribe reach immense girth, and are quite inaccessible to the woodman's axe, rotting as they stand, and forming soil for carpets of Killarney, filmy, and hares-foot ferns. The warm, moist, and shady valleys form a paradise for ferns, the Dicksonia, Woodwardia, and Asplenium rivalling each other in size. The botany of the island is of great interest, especially in its relations to that of Europe and Africa; but the visible fauna, except Mollusca, is meagre, and the comparative absence of birds and butterflies is felt. Beyond the foreground of vast walls of red and brown rock, often 3000 to 4000 feet high, clothed and softened by dark green foliage, are peaks weathered into most fantastic forms, and rising to 6000 feet. But if this grand scenery could become monotonous, there are English moorlands on the Paül da Serra, barren tracts of rock at the extremities of the island, cultivated country with lanes hedged by fuchsias and hydrangeas at Camacha. The coast-line is magnificent in the extreme, one headland on the south presenting a vertical cliff to the sea of 2000 feet, and another, a mountain clothed with myrtle on the north, being scarcely inferior to it. The ascent of some of the peaks might tax even an experienced Alpine climber's nerves; but the effect of ocean rising to the skies like a blue wall all round is very striking when seen for the first time from a lofty island peak. In summer the heat is not oppressive among the mountains, and now that the fares are no longer unreasonable, one with an overtaxed brain seeking rest might make a worse choice than Madeira for a ramble. To him Miss Taylor's exhaustive book is inexhaustible, and the itineraries in it, sketched by Mr. Charles Cossart, invaluable.

No mention of Madeira is complete without allusion to its staple produce—wine. The export seems never to have exceeded 20,000 pipes annually, and though this was reached as early as 1750, yet this is far below the producing power of the island. The vines, destroyed by Oideum, have again severely suffered from Phylloxera, but the shipments, owing chiefly to the persistent efforts of Messrs. Cossart Gordon, are steadily recovering. It cannot be too widely known that Madeira is a pure wine, for at the price of grapes there, there is no incentive to use anything but grape juice in its production, though Madeira is exported to other wine countries, presumably for manufacture into sherry. The retail price is only artificially maintained by a pretended scarcity.

J. STARKIE GARDNER

Tschermak's Lehrbuch der Mineralogie. Part II. (Vienna: Alfred Hölder.)

IN this part of Prof. Tschermak's text-book the discussion of the optical and physical characters of minerals is continued and concluded in a manner more scanty than was perhaps to be anticipated from the first part. The results of many of the most recent additions to our knowledge of the structure of mimetic and twin-crystals, such as milarite, microcline, &c., as shown by their optical properties, are, however, included. In the chemical introduction which follows, too much space is devoted to the exposition of the fundamental principles of chemistry, such as those of equivalents, atoms, and the theory of types; as also to the principal simple tests for the various elements. A fair knowledge of chemistry is absolutely necessary to the mineralogist, and Prof. Tschermak might well have expected his students to bring such a knowledge with them. In this case his exposition is unnecessary, while if the student is ignorant of chemistry, it is hardly likely to be adequate, and it undoubtedly diminishes the space available for the principles of isomorphism and polymorphism.

Considerable space is given to the description of the situations in which minerals are found, and of their associations in beds and veins. Another chapter is devoted to mineral genesis and to the decompositions and transformations which minerals are liable to under the action of natural agencies. These subjects, common to the mineralogist and geologist, are apt to suffer through being relegated by each to the other, and we are glad to see the importance attached to them by Prof. Tschermak.

The systematic description of the principal minerals is to occupy the whole of the third part. This volume extends as far as the elements and sulphides, and gives us a foretaste of what is to come. The descriptions are well done, and give much more information than the ordinary text-books do. This information is, moreover, given in general language, and the different forms are better and more fully illustrated than is usually the case. The minerals discussed are those of importance either from their utility, the frequency of their occurrence, or their scientific value; and the selection, from this point of view, is well made.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Scientific Exploration in Egypt

Now that we have embarked in a war in Egypt, it is to be hoped that steps will be taken to have a proper staff of scientific explorers attached to the army with facilities for conducting their investigations. There are periods of rest in a campaign during which soldiers and others may be usefully employed in conducting excavations at comparatively slight cost; and difficulties in the way of investigation, arising from the requirements of trade and industry, disappear in time of war. The deposits of the Delta require to be examined. The gravels of the Nile Valley have to be connected with their animal remains. Much has to be done for the earliest and best period of Egyptian art, and the Stone Age of Egypt has to be fixed with certainty, the importance of which cannot be over estimated in connection with the earliest civilisation of the world.

I trust also that we shall not rob Egypt of her antiquities to any great extent. It may be useful to complete our typical series to a limited extent, but if Boulak should be happily preserved, I hope it will be preserved for Egypt, and not brought home. Nothing would serve more to prove that we go there to civilise and not to rob. The means of communication are now so easy that all who are interested in Egyptology can see it there. Steam and railways have materially altered the requirements of education in this respect. Humanity, and British humanity in particular, now pours through all the great arteries of the world, and people observe and study more abroad than at home. The time has passed when antiquities should be regarded as trophies of war. It is no longer necessary for instruction to hoard up valuable specimens of foreign antiquities in European museums. So long as science has access to the materials of knowledge, that is all that it is necessary to bring away; and national museums, with the limited space at their disposal, should more and more become devoted to local collections. Besides which, it should be remembered that the atmosphere of Egypt preserves antiquities in a way that no other climate can do; and when this fact hereafter becomes fully impressed upon the public mind, the time may come when subscriptions will be raised to take back obelisks and put them up again in their proper places; at any rate we have enough of them weathering and withering in smoke and damp. They are quite out of place in European towns, and seem to hold up a finger of caution to us to proceed no further in that direction. But the opportunity for exploration should not be lost. The French savants did their work thoroughly during their military operations in that country, and it would be shameful if, with the knowledge now at our disposal, the British expedition did not achieve more for the promotion of science than was effected by Napoleon half a century ago.

Carlsbad, August 3 A. PITT-RIVERS

Francis Maitland Balfour

THE memoir of Prof. Francis M. Balfour, published in NATURE, vol. xxvi. p. 313, appears to have been founded, as far as his life at Harrow is concerned, on incomplete information; and I therefore ask your permission to supplement it with my own reminiscences.

He entered Harrow School in January, 1865, and when he had reached the upper part of the fifth form in 1867, I was appointed to give instruction in natural science. Although this subject was not taught in any of the forms which Balfour passed through, he soon afterwards eagerly availed himself of the opportunity offered of taking lessons in practical work in biology. This continued without intermission until he left the school for Cambridge more than three years afterwards. He was always ready to spend as many hours as I could give him for work with the microscope and in making dissections. With Dr. Rolleston's "Forms of Animal Life" as guide, he dissected nearly all the typical examples described in that book. In the same way he gained a knowledge of osteology, using a small collection of skeletons which received, for his special benefit, the important additions of a complete crocodile, and an armadillo, several incomplete skeletons of ornithorhynchus, and echidna. No part of comparative anatomy was neglected, but of such an extensive subject, much of his knowledge was necessarily derived from books only, but it was sound, being based on Huxley, Müller, Kölliker, and the like. He had the opportunity also of learning elementary botany.

All this work was carried on under conditions with which only a boy of his energy and indomitable perseverance could have coped. At first he had some difficulty in acquiring skill in the purely mechanical details of dissection, but he determined to overcome this difficulty, and he succeeded. The time at his disposal for biology was chiefly the half-holidays, and for such work no marks could be given by his form masters, but on the contrary, it is only too certain that his position in other subjects was affected by his devotion to natural science.

Those who managed the affairs of the School Scientific Society in 1868 (two years before Balfour left Harrow), showed their appreciation of his remarkable powers by asking Prof. Huxley to award the prize, which had been offered, through the liberality of Mr. C. J. Leaf, for the best essay written during the previous holidays, being a description of some district known to the author. This unusual step was taken when it was found that the essay sent in by Balfour and another by his friend A. J. Evans, were of such rare merit, that it was felt that they were worthy of being brought under the notice of such a distinguished man as Prof. Huxley. His opinion of the value of these essays fully justified this view.

Balfour's knowledge of geology was chiefly gained at home, and no doubt it was of considerable service to him in the competition for the Natural Science Scholarships, which he gained soon after he went into residence at Cambridge.

Whether the teaching referred to in the previous lines was of advantage to him or not, could be best determined by himself, and it is interesting to have his judgment on this point when the recollection of it was fresh in his mind. In a letter dated "Cambridge, April 28, 1871," he says: "Many thanks for your congratulations on my success, which is certainly chiefly due to you." This opinion he again very warmly expressed to me when I had the pleasure of spending a few days with him in the same year after the meeting of the British Association at Edinburgh.

He left Harrow in August, 1870, having spent nearly six years in the school. G. GRIFFITH

Harrow, August 7

I AM sorry that I omitted in my brief sketch to point out the benefits which Balfour undoubtedly derived from the science teaching at Harrow, and I am sure my friend Mr. Griffith will understand that it is as far as possible from my wishes to fail in acknowledging the fruit of the labours which he has been carrying on there these several years with such zeal and energy. There can be no doubt, I think, that the training which Balfour had under Mr. Griffith not only helped towards his gaining the scholarship, but materially contributed to making him the man he was. What I wrote concerning his reputation at Harrow, referred rather to what I understood was the general opinion of the school, than to Mr. Griffith's own forecast of what Balfour might become; the latter I have known for a long time to be so sanguine as to come near the truth. M. FOSTER

On "getting" Coal by Means of Caustic Lime

IN an article on this subject (NATURE, vol. xxvi. p. 299) Mr. William Galloway states that this system "has been found by experiment to be incapable of breaking down a hard rock or shale roof," and is, therefore, not likely to have anything but a limited application.

Will you allow me, as one who has had a good deal to do with the new process, to assure Mr. Galloway that so far as it has yet been applied, it has answered every purpose in respect of which gunpowder or wedging have been hitherto used.

We have not yet had time to make a series of experiments with the lime-process on hard rock, &c., as our attention has been until now turned exclusively to the getting of coal, especially in those mines in which, from their fiery nature, the use of powder has been prohibited. In the Shipley Collieries, where the lime-process has been in constant operation for many months, it is regularly applied to one of the hardest seams in the Midland coal-field, the toughest part of which is that next the roof, and this portion could never be got by wedging in the ordinary way, but had subsequently to be hacked down into slack—by the lime process, however, the coal is parted clean from the roof, along the entire face operated on.

In other districts where it has been proved to be a complete success, the places selected for experiment were invariably the hardest in the mine. The cases where the tamping has been blown out are extremely rare, and have been due to causes immediately and easily rectified.

We have no reason to believe that the process would fail in its application to the mining of shales, iron ores, &c., and this point will be settled by experiment before long, pending which Mr. Galloway's conclusion on the subject is at least premature.

PAGET MOSLEY

81, Warwick Road, Earl's Court, August 10

IN stating that the caustic lime process was likely to have only a limited application in coal-mining operations, it was not my intention to convey the impression, as Mr. Mosley appears to think it was, that the area of its usefulness would necessarily be a small one. On the contrary, I believe it could be successfully employed in getting coal under a large variety of circumstances.

Mr. Mosley's connection with the subject could not well be more intimate than that of the gentlemen who supplied me with the information brought forward in the article referred to, and I understood them to say that experiments had been made with the roof of Shipley Collieries, giving results which amply justified the conclusions I stated.

The tamping was blown out of three or four of the holes which I saw operated upon, and this is certainly not what would be called an "extremely rare" occurrence. At the same time it did not appear to affect the final result in any way.

I said nothing about the probability of the process failing or succeeding in its application to the mining of shales, iron ores, &c., and stated no conclusion in this connection which could in any way be affected by the results of the experiments which Mr. Mosley says are pending. WILLIAM GALLOWAY

Cardiff, August 14

Science at the Victoria Hall

THE immediate object of the Victoria Hall Committee is to provide healthy amusement in place of the unhealthy sort too often found in places of cheap recreation, and does not appeal specially to scientific men as such. But they have a scheme on hand for next autumn to which I venture to call your attention. They would like to devote one evening in the week for popular lectures, and as a previous experiment they propose to have during October and November a series of very elementary popular addresses on scientific subjects of about half an hour in length, to be introduced in the beginning, or middle, or end of the temperance demonstrations which take place on Friday evenings. It is hoped that an interest in such matters may be awakened in the audience (usually numbering ten or twelve hundred, or during the winter more than this), which assembles at these demonstrations. It is an audience less of artisans than of labourers and costermongers, among whom the demand for scientific teaching must be created as well as supplied. If once it can be shown that such addresses are appreciated, we have good hope of efficient help in carrying them on, but we should be grateful for offers of help in the pioneer course. Dr. W. B. Carpenter, Dr. Richardson, and one or two others have given conditional promises, but we have not yet sufficient names for a long enough series to try the experiment fairly.

To simplify and popularise science to the utmost, without lowering it, is not a task which can be performed by those who have no qualification except goodwill, and as, unfortunately, the Victoria Hall is not yet self-supporting, the committee cannot offer anything like adequate remuneration for the services of competent and therefore busy men. They would gladly be responsible for the expense of providing lime-light, or hiring apparatus for experiments, but beyond this they must appeal to the public spirit and generosity of scientific men.

Communications may be addressed to the Honorary Secretary, Royal Victoria Coffee Hall, Waterloo Road, S.E., or to Miss C. A. Martineau, Walsham le Willows, Bury St. Edmunds.

ONE OF THE COMMITTEE

Spelling Reform

IN your note last week on the United States Spelling Reform Report, there is a slight misapprehension. It is said that the result of adopting a phonetic spelling will be the break-up of the English language. This is quite erroneous. Phonetic spelling simply represents pronunciation, and if the phonetic spelling of London English differs from that of Colonial English it can only be because the pronunciations are different; that is, because the language has *already* broken up. On the other hand, if the pronunciations are the same, the spellings will be the same, and I fail to see how an identical spelling in London and Australia can bring about a disruption.

In the present state of Biblical criticism, I rather wonder that the tower of Babel should be appealed to as evidence of *Hebrew* thought; but if the Hebrews were really so impressed with the confusion of tongues, and if phonetic spelling is really so conducive to that confusion, then let me ask: Why did the Massorites, with that story before their eyes, go and make the originally phonetic Hebrew alphabet more phonetic still by adding the finest set of vowels that has ever been used? Why, except that they knew, as Prof. Sayce and Dr. Tylor know, and the late Charles Darwin knew, that phonetic spelling is the only thing that preserves language and its history from utter decay.

JOHN FENTON

Spelling Reform Association, 8, John Street, Adelphi,
W.C., August 14

Possible Sound Organs in Sphingid Pupæ

IN recently characterising the pupa of *Sphinx catalpæ*, Boisd., for my report as entomologist to the Department of Agriculture, I was struck with the occurrence on the anterior border of each of the larger movable abdominal joints (viz., abdominal joints 5, 6, and 7) of a peculiar elongate concavity, a structure not mentioned by Westwood, Burmeister, Kirby and Spence, Girard, Clemens, Harris, Graber, or any modern author whom I have been able to consult. There is an approach to it in the pupa of *Ceratomia amyntor*, and it occurs in that of *Sphinx harrisii* in similar position and form as in *S. catalpæ*. In *Macrosila 5-maculata* it is somewhat above the spiracles, and that on the fifth abdominal joint has a second larger ridge running around it posteriorly. It does not occur in any of the species of the genera Sesia, Thyreus, Darapsa, Deilephila, Philampelus, and Smerinthus in my collection. It has no internal connection with the respiratory or circulatory systems, and its function is probably sound-producing by friction with the posterior margin of the preceding joint. This organ may, in fact, throw some light on the method by which the noise is produced which the pupa of *Sphinx atropos* is capable of. Unfortunately, I have no pupæ of that species for examination.

I shall be glad to learn from any of your Lepidopterological readers if they are familiar with this structure on any other pupæ or know of any record of it. C. V. RILEY

Washington, D.C., U.S.A.

Meteorology of the Antarctic Region

IT is well known that on the Antarctic lands perpetual snow descends much lower than in corresponding latitudes of the northern hemisphere. The chief cause of this is, no doubt, the difference of climate due to the preponderance of land in the northern hemisphere and of water in the southern. But there is another cause, of sensible magnitude, which I have not seen mentioned. In high southern latitudes the barometer stands permanently nearly an inch lower than in corresponding northern latitudes, and this must cause a permanently lower temperature in the Antarctic regions. That is to say, a depression of an inch in the barometer corresponds to about 1000 feet of mountain ascent; and any station in the Antarctic region must therefore be as much colder than a corresponding one in the Arctic region, as if the Antarctic station stood 1000 feet higher above the sea-level than the Arctic one.

The cause of the barometric depression in the Antarctic region is probably the centrifugal force of the west winds, or "counter-trades," which, as Maury remrrks, surround the South Pole with "an everlasting cyclone on a great scale."

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, August 8

RECTOR (whose appeal for help in protecting a granite boulder in his country parish we inserted in No. 663) requests us to acknowledge with many thanks the following contributions:—Saxo, 2*s.* 6*d.*; William S. Layman, 2*s.* 6*d.*; J. W. A., 5*s.*

SUN-SPOTS AND MARKREE RAINFALL

BY aid of R. Wolf's series,[1] I have been endeavouring, if possible, to trace the effect of the different state of the sun's surface, as shown by the extent of its spots, on our climate. I distributed the annual rainfall, registered here 1833-1863, into ten classes, according to the corresponding values of "the relative numbers" r, as exhibited in Table I. These relative numbers have been determined by Prof. Wolf from a discussion of the registered number of spots and groups of spots on the sun, and are supposed to be proportional to the area covered by spots on the sun's surface. The mean rainfall M, the average of the thirty-one years, is 37·254 inches. o is the rainfall regis-

---

[1] "En désignant par g le nombre des groupes de taches nus un jour quelconque sur le soleil, une tache isolée comptant pour un groupe; par f le nombre des taches contenue dans tous les groupes, nombre que j'estime approximativement proportionel à la surface tachetée; et par k un coefficient dépendant de l'observation et de son instrument, et déduit d'observations correspondantes, en supposant ce coefficient égal à l'unité pour mai et pour le grossissement 64 d'un *Fraunhofer* de 4 pieds, je pose: $r = k(f + 10g)$, et je nomme r le *nombre relatif* de ce jour. La moyenne de tous les nombres relatifs appartenant à la même année donne le nombre relatif de l'année." R. Wolf. Mémoire sur la Période commune à la Fréquence des Taches Salaires et à la Variation de la Déclinaison Magnetique (Memoirs of the Royal Astronomical Society, vol. xlii., 1877, Part vi).

tered during a certain year −. I tried to reduce the difference o − M (Table II.) by applying to M a constant correction, $10x$, and at the same time a correction ry proportional to the respective relative number. The equations of condition of the form—

$$10x + ry + o - M = 0$$

are exhibited in Table I., the last column of which exhibits the remaining errors, v, *i.e.* the difference between the registered rainfall, o, and the calculated, $C = M - 10x - yr$, after that the quantities x and y had been obtained from the equations of condition by solving them by aid of the method of least squares. It will be remarked that v is far smaller than o − M in Table I., the average of several years, but the comparison from year to year, o − C as exhibited in Table II., shows but a small decrease in the differences. The result is—

$$\underset{\text{inches.}}{C} = \underset{\text{inches.}}{34·435} + \underset{\text{inches.}}{0·04785}\,r = \underset{\text{inches.}}{37·254} + 0·04785\,(r - 58·91).$$

TABLE I.

Years: 1800 +	Equations of condition.	v.
56, 55, 33	$10x + 7·4y - 3·35 = 0$	−0·89
43, 34, 44	$10x + 15·2y - 1·89 = 0$	+0·20
54, 57, 42	$10x + 22·3y - 2·87 = 0$	−1·12
45, 41, 53	$10x + 38·4y - 0·23 = 0$	+0·76
63, 52, 58, 35	$10x + 53·3y + 0·84 = 0$	+1·11
46, 62, 40	$10x + 60·8y - 1·07 = 0$	−1·16
51, 50, 61	$10x + 70·2y + 4·04 = 0$	+3·50
39, 59, 60	$10x + 89·5y + 2·52 = 0$	+1·06
49, 47, 38	$10x + 99·0y - 1·99 = 0$	−3·91
36, 48, 37	$10x + 127·0y + 3·71 = 0$	+0·45

TABLE II.

Year.	r.	o. inches.	o − M. inches.	o − C. inches.
1833	9·4	44·49	+7·24	+9·60
1834	13·3	36·50	−0·75	+1·42
1835	59·0	37·34	+0·09	+0·08
1836	119·3	41·39	+4·14	+1·25
1837	136·9	40·29	+3·04	−0·70
1838	104·1	31·00	−6·25	−8·41
1839	83·4	33·92	−3·33	−4·50
1840	61·8	30·77	−6·48	−6·63
1841	38·5	35·55	−1·70	−0·73
1842	23·0	33·25	−4·00	−2·30
1843	13·1	35·96	−1·29	+0·89
1844	19·3	33·63	−3·62	−1·73
1845	38·3	40·37	+3·12	+4·10
1846	59·6	37·56	+0·31	+0·28
1847	97·4	37·17	−0·08	−1·92
1848	124·9	41·22	+3·97	+0·81
1849	95·4	37·63	+0·38	−1·37
1850	69·8	37·12	−0·13	−0·65
1851	63·2	40·25	+3·00	+2·79
1852	52·7	45·72	+8·47	+8·75
1853	38·5	35·17	−2·08	−1·11
1854	21·0	34·77	−2·48	−0·67
1855	7·7	29·36	−7·89	−5·44
1856	5·1	27·87	−9·38	−6·81
1857	22·9	35·14	−2·11	−0·40
1858	56·2	34·34	−2·91	−2·79
1859	90·3	41·65	+4·40	+2·90
1860	94·8	43·74	+6·49	+4·77
1861	77·7	46·52	+9·27	+8·36
1862	61·0	40·23	+2·98	+2·88
1863	45·4	34·97	−2·28	−1·64

It should be remarked that the receiver of the guage is placed on the top of the library, 16 feet above the ground and 148 feet above mean sea-level. I have placed another guage 6 inches above the ground and 110 feet above the sea, as levelled from bench-mark on observatory wall, and have taken precautions against evaporation from this guage. By comparing the results from the two guages during the last five years, I find that the rainfall registered by aid of the upper guage must be multiplied by 1·2426 in order to indicate the rainfall at 110 feet above sea. The formula properly reduced is therefore—

$$C = \underset{\text{inches.}}{46·292} + \underset{\text{inches.}}{0·05946}\,(r - 58·91).$$

I am only too painfully conscious that this result has been derived from insufficient data, but it might be interesting to see whether it would be confirmed by a similar discussion of a sufficiently extensive register kept at some older observatory.

The average monthly rainfalls are as follows:—

	inches.		inches.
January	3·451	July	3·284
February	2·771	August	3·599
March	2·485	September	3·249
April	2·460	October	3·881
May	2·026	November	3·530
June	3·044	December	3·474

Markree Observatory, July 17 W. DOBERCK

THE NEW REPTILE HOUSE AT THE ZOOLOGICAL SOCIETY'S GARDENS

THE present Reptile House in the Zoological Society's Gardens adjoining the Lecture Room, is an old wooden building, which in the early days of the Society was used for lions and tigers, and is now in a very bad state of repair. Besides this it is much too small for the present collection of reptiles. The cages which it contains are always over full, while the tortoises are necessarily lodged in a separate house, and the crocodiles are kept in a building properly destined to contain sloths and marsupials. Moreover, most of the compartments in the present Reptile House are accessible only from the front, which renders it inconvenient, not to say dangerous, to open them in the day-time, when the house is filled with sightseers. Under these circumstances, the Council of the Society have determined to construct an entirely new building for the better accommodation of the reptiles at the southern corner of the Gardens, and having obtained the necessary permission of H.M. First Commissioner of Works, will commence operations immediately.

The new Reptile House will be 120 feet long by 60 feet in breadth, with a large porch and double entrance at the front, and keepers' and workers' rooms in the rear. The building will be of brick with corse-hill stone dressings, the roof of iron, slated on the north slope, and provided with ample skylights on the south slope. The house will face due south. It will be fitted with fixed cages for the reptiles on the north, east, and west, leaving the south side (which will be nearly entirely of glass), available for movable cases (such as are now in use in the Insect House), for the smaller and more delicate objects. There will be a large oval pond for crocodiles in the centre of the building, and two smaller circular ponds on each side of it for other aquatic reptiles. The fixed cages, which will be from thirty to forty in number, will be fronted with plate-glass, and the only means of access to them will be from the keeper's passage in the rear, so that there will be no possibility of the animals escaping into the space occupied by the public.

The new Reptile House, will, it is expected, be completed and roofed in before Christmas, and as the hot-water apparatus will be finished by the same date, it will be possible to dry it thoroughly during the winter, so that the reptiles may be moved into their new quarters early in the ensuing summer.

The designs for the new building have been drawn by Mr. C. B. Trollope, and the contract for its erection has been undertaken by Messrs. Hannen and Holland.

The Society's collection of reptiles consists at present of 57 tortoises, 10 crocodiles, 95 lizards, and 83 snakes. Of the last-mentioned, 10 are large pythons and boas, and 14 belong to venomous species. Besides the reptiles there are 56 Batrachians living in the Gardens, which for the present at least, will be kept along with the reptiles.

There is, therefore, no fear of the new Reptile House lacking inhabitants, when ready to receive them next year.

DIFFICULT CASES OF MIMICRY

I SEE a notice regarding mimicry and simulation, by Mr. A. R. Wallace, in NATURE, vol. xxvi. p. 86, and beg to forward the case of a caterpillar mimicking a shrew, as a peculiar instance of this curious law.

Here we see the insect unconsciously simulating the very animal that most likely feeds on itself, or at least an insectivorous mammal. Passing through a dense forest near a path, I suddenly came on the caterpillar, at about five feet from the ground, on a stout creeper, and of course mistook it for a shrew. Its remaining, and not running off, induced me to look closer, when I saw the green markings, and at once secured the prize, and, after making a sketch or two, put it in my "hatching" cage; unfortunately, I could not find what it fed on, and after spinning a pale greenish cocoon, it died. The natives did not seem to know it. When moving along, it does so as other caterpillars, as seen in the outline 1, of which 2 is plan of the head. If suddenly disturbed, it at once strikes the peculiar pose, as seen in the sketches, and retains it for some time.

The general colour is a neutral to brown-grey, beautifully marked, and which I have not attempted to imitate; the general appearance is dark, except where the greenish-yellow spots occur. It is the first case I know where a caterpillar mimics a vertebrate animal. The cases are almost innumerable out here, where insects mimic each other and similar or different kinds, or leaves, seeds, flowers, sticks, pieces of grass or clay, &c., &c.; but we see it also in many other cases, not always protective, though invaluable to the animal or the insect. The tiger has one call, when hunting, so like the loud whistle of the Samber (deer) that only an expert and old resident can tell the difference. The deer, if within range, *run to it*, and I have myself shot a Samber at twenty yards that dashed up on my whistling loudly, with a leaf; unfortunately, native shikaries are only too expert at this. Again, the eye and nose lumps of a crocodile are so like lumps of foam that I have often drifted past close to one in my *Rob Roy*, and only found it out by the lump of foam quietly and suddenly *sinking* below the surface of the muddy water. In the case of the tiger the simulation was by sound, to enable it to get food; in that of the crocodile the same end is gained by simulation of appearance, enabling the animal to drift close to prey without alarming it.

S. E. PEAL

Asam, June 25

Caterpillar that simulates a Shrew (full size).

THE WASHBURN CHRONOGRAPH

THE article on the Brussels Chronograph (NATURE, vol. xxvi. p. 107) induces me to send a brief description of the chronograph of this observatory, which may be taken as representing the form usually adopted by the best American makers, Alvan Clark and Sons, Fauth and Co., Stackpole and Brothers, &c. The accompanying engraving gives a good general idea of it. The scale may be obtained by remembering that the iron base plate is 21½ inches by 11½ inches. The barrel is 14 inches long by 7 inches in diameter. The paper used is 23⅛ inches by 13 inches which provides for a lap at the line of junction. There is room for the observations of two hours and forty minutes. The weight employed is fifteen pounds, and usually a double pulley is used to diminish the fall.

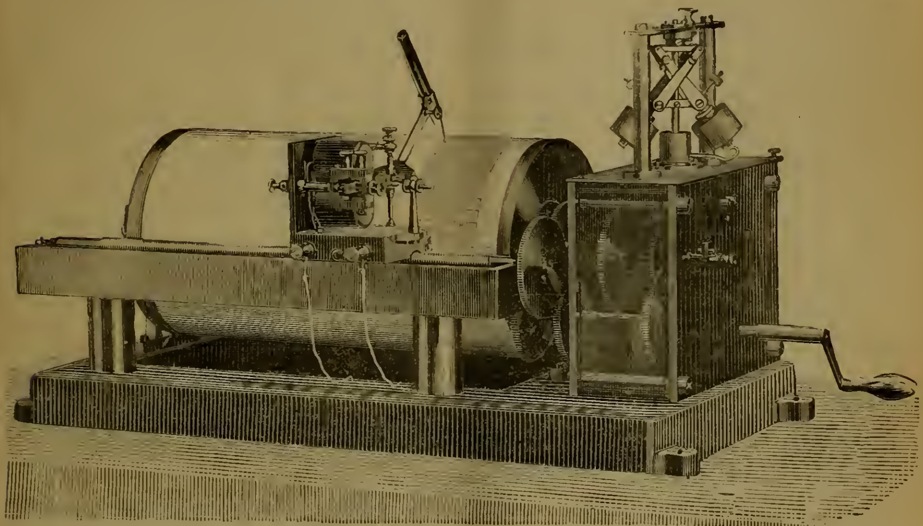
The chronograph can be wound while it is going, without affecting its rate. The barrel can be taken out of its Ys if desired, or one end of the barrel can be lifted by a small lever, so that it can be turned around to put on or take off a fresh sheet of paper. In practice several sheets of paper are put on at a time, so that the last one has simply to be removed when it is filled, and the pen-carriage moved back (to the right) to continue the record. This can be done without stopping the chronograph.

A second of time is 0·36 inches in length, in the usual adjustment. The governor is a double conical pendulum, acted on directly by the weight. It thus tends always to run too fast, as it runs faster and faster, the pendulum bobs fly out, and finally strike the point of a horizontal hook shown in the drawing. This hook is attached to a little cylinder of brass embracing the vertical axis (also shown), and when the hook is touched by the pendulum bob (as it is shown in the cut), the hook and the brass cylinder are carried about the axis through a certain angle. The work thus done diminishes the speed of the pendulum, which falls in towards the axis slightly. In this way the governor and also the barrel rotate alternately a little faster and a little slower than the desired mean rate, but these variations are vanishingly small and of no account whatever in astronomical work. The pendulums strike the hook on the average from sixty to ninety times per minute.

The pen-carriage is nothing but an electromagnet mounted on a frame, which is driven by an endless screw from right to left in the cut. The carriage may also be lifted by the hand and moved in either direction. This is a great convenience in certain kinds of work, such as comparing a number of clocks together. The record for each clock can be separated from that of every other clock by a blank space.

The pen is of glass, filled with a thick ink made according to the following formula which is used at the Naval Observatory. This ink does not freeze in winter weather.

Water	4 fluid ounces.
Alcohol	2 ,,
Concentrated glycerine	1 fluid drachm.
Crystallised Aniline Blue	40 grains.



Filter very thoroughly and draw off for use through a stop-cock. A common stylo-graphic pen, if held nearly vertical and weighted with a little piece of lead, is nearly as good as the glass pen, and somewhat cleaner.

The signals from the clock and observing key are received through the two flexible wires shown in the cut. These signals can be repeated, by connections to screw-posts, on the pen-carriage.

The whole machine is light and portable. It takes, say, fifteen minutes to move it from one room to another. It can be worked equally well with a break or a make-circuit. Its price is 325·00 dollars. The makers of our chronograph are Fauth and Co., Washington, D.C., but the design is that adopted by the Clarks.

The first *double* conical pendulum of this kind was made by Dr. Henry Draper, and applied to the driving-clock of his photographic telescopes. The first governor on this principle was adopted by Alvan Clark and Sons, for driving the heliostats used in the United States Transit of Venus Expedition of 1874. These governors had, however, only a single pendulum, and not two crossed pendulums, as in the cut. I am induced to send you this brief account of a simple and useful device which has had a thorough trial of 31 years (it was exhibited by G. P. Bond at the Crystal Palace in 1851), which is always satisfactory; which never gets out of order; because it is a standing wonder to us, on this side of the water, why the expensive and complicated double-pen chronographs continue to be made and used in England, and on the Continent. The inclosed sheet, which is selected absolutely at random from a pile of such records, will show the kind of work these machines will do; and all the questions which have been agitated with regard to the relative accuracy of one and two pen-chronographs, seem to me to have been practically settled by the observations made at our principal observatories for a score of years past. I need only mention the longitude campaigns of our Coast Survey, of the Naval Observatory, of the Army Engineers, and the standard work of the Transit circles of Washington and Harvard College, in this connection.

I am sure that it only needs a trial of the form indicated to prove its superiority in every respect for astronomical purposes. All objectors on the score of accuracy, &c., should refer to the *Annals* of the Harvard College Observatory, vol. i., part ii., pp. xxxiv., where they will find what seems a sufficient answer.

EDWARD S. HOLDEN

Washburn Observatory, University of Wisconsin,
Madison, June 30

THE LIMIT OF THE LIQUID STATE OF MATTER

THE conditions under which an investigation is carried out often predetermine the conclusions to be drawn from the observations made. That this has been the case with the observations made upon the upper confines of the liquid state, there is now ample evidence to show. When Cagniard de Latour, on heating liquids in sealed tubes, noticed the disappearance of the liquid surface, he came to the conclusion that the liquid state had ceased to be possible, and that the substance had passed into the gaseous state. But Latour had no means of varying the volume of his liquid to observe whether or not increase of pressure might again induce liquefaction. This defect was removed by Dr. Andrews, who constructed the well-known apparatus for varying the volume by means of a screw. And it is to the work performed with this apparatus that the above remark is applied. By two modes of observation Dr. Andrews arrived at the conclusion that the liquid and gaseous states of matter were continuous. The experiments being conducted in transparent glass tubes, the appearance of the contained fluid constituted one mode, and the registration of the pressure constituted the other. *Neither of these methods could by the necessities of the case give any aid in determining the state of matter.* Dr. Andrews's method of demonstrating the continuity, by passing from a lower to a higher temperature under a pressure which prevented the formation of vapour, ensured the homogeneity of the fluid under examination, and precluded the existence of a visible liquid surface; and as liquid and gas are equally transparent, no tidings of the state of the fluid under examination could come to him by observations of its appearance. How did Dr. Andrews tell when his tubes contained liquid? By lowering the pressure till a meniscus was seen. *Then the formation of a meniscus is the only test of the liquid state.* Dr. Andrews then obliterated the only ocular test of the fluid's condition by increasing the pressure, and raised the temperature till on again reducing the pressure no meniscus was formed, showing the fluid to be gaseous, and he then declared that no sudden change of state had occurred—that is to say, that it was impossible to say that the fluid was either liquid or gaseous, but that it had probably passed through an intermediate state. Of course a change of state had taken place, and if we only reflect that the change from cohesion to repulsion is caused by the thermal velocity of the molecules, and not by the number of them in a space, the change should depend upon temperature and not upon pressure.

The characteristic property of the liquid state is then the possession of cohesion sufficient to form a surface, or simply surface tension; and could this property be retained in a visible form at all pressures, the existence of the continuity enunciated by Andrews could be put to a crucial test. By compressing hydrogen over various liquids in which it is insoluble, I was enabled to carry the above proposition into effect, and after several hundreds of experiments, detailed in a paper read before the Royal Society, the conclusion was arrived at that the two states are not more continuous than are the solid and liquid states, but are separated by an isothermal passing through the critical point. In fact by Latour's or Andrews's method, where the liquid was in contact with its own vapour, the critical point is the only place where the direct passage from liquid to gas is visible, but the employment of hydrogen for retaining a free surface enables us to observe the passage at any pressure, and it takes place as suddenly at 200 atmospheres pressure as at the critical pressure. Thus the critical point is the termination of an isothermal line, which is the limit of the liquid state.

As to the other mode employed by Andrews—namely, pressure—continuity of pressure does not prove continuity of state. If it did the continuity of the solid and liquid states could easily be proven. In fact, the irregularities observed by Andrews in the vicinity of the critical point rather lend support to the views that a change of state takes place there.

We may state the change thus:—The cohesion of the liquid state is weakened as the thermal motion increases, till the repulsion is in excess of the attraction, and the gaseous state ensues. The evidence I have collected from capillary phenomenon in the paper above referred to proves this to be the case, and shows that pressure has no effect in altering the occurrence of the phenomenon. Thus we are led to the conclusion, that so far from the liquid and gaseous states of matter being continuous and indistinguishable, the liquid limit or "absolute boiling point" *is the only fixed point among the properties of matter.* The freezing point can be altered by pressure, and besides, many bodies like ethyl alcohol may have no freezing point, probably becoming more and more viscous till absolute zero is reached. But all substances may be made to pass into the gaseous state, and even delicate compounds may be rendered gaseous without decomposition when under sufficient pressure. We see then that this important change of state, for which I propose the name Cohesion Limit, and which till lately was supposed to have no existence, is in reality the only fixed point in the relations of the states of matter, being determined by temperature alone.

J. B. HANNAY

INTERNATIONAL METEOROLOGY

THE second meeting of the International Meteorological Committee took place at Copenhagen, August 1-5 inclusive. All the Members were present, except Prof. Cantoni, who had resigned his seat on the Committee on account of health. Prof. Tacchini was unanimously elected in his place. The following brief account of the more important of their proceedings is in the numerical order in which the respective subjects were discussed.—

It was resolved—

(*a*) To organise an exhibition, in connection with the International Fisheries Exhibition, London, of the methods and apparatus used in different countries for giving weather intelligence and storm warnings to the coasts, and of the instruments, &c., used in the study of ocean meteorology.

(*b*) To issue a circular to all existing organisations, requesting them to supply data as to their condition and operations up to the end of the current year.

(*c*) To request the several institutions to be more precise in the information published by them as to the hour of occurrence of rain and other phenomena.

(*d*) To request all institutions to append to their Daily Bulletins, Monthly Sheets giving the mean results for the month, in the same way as the London Office has done since 1880.

(*e*) To request all institutions to furnish particulars of any stations which may exist in distant localities, especially in the Torrid Zone, South America, and the Islands of the Pacific, at least during the period of the International Polar Observations, and to publish the names of such stations in the Polar Bulletin issued by Prof. Wild.

(*f*) To express approval of the plan proposed by Capt. Hoffmeyer and Dr. Neumayer to publish daily synoptic charts of the Atlantic Ocean, with an explanatory text, at the cost of the respective institutions of Copenhagen and Hamburg, and to recommend other institutions to contribute materials for the work, if they can.

(*g*) M. Tietgens, Chairman of the Great Northern Telegraph Company, submitted to the Committee a plan for a cable to connect Iceland and the Faroes with Europe, the expense to be met by the receipts from meteorological telegrams. The Committee, while recognizing the very great importance which information coming from Iceland and the Faroes must possess in relation to the issue of storm warnings and forecasts in Europe, felt that they were not in a position to express an opinion on the practical execution of the project.

(*h*) The Sub-Committee nominated at Berne (MM. Mascart and Wild) submitted specimens of their proposed International Reduction Tables. It was resolved to print a full page of each of these tables, with explanations, and submit them to meteorologists for their opinion, with the view of subsequently publishing the tables by means of subscriptions from the different institutes.

(*i*) M. van Rysselberghe's proposal to communicate by wire the indications of his instruments at out stations to central offices was considered, and that gentleman was requested to draw up and publish a detailed scheme for its execution.

(*j*) A Committee was nominated, consisting of M. de Brito Capello, Rev. Clement Ley, and Prof. Hildebrandsson, to draw up a scheme of instructions for the observations of "cirrus" clouds.

(*k*) It was resolved that the prospects of the preparation of a general catalogue of Meteorological Bibliography were not favourable to its execution, and that the only action for the Committee to take was to invite the heads of the different institutes to prepare catalogues of the meteorological literature of their respective countries.

The Members of the Committee were most hospitably entertained during their stay in Copenhagen. They were honoured with an invitation to dine with the King on the 5th inst., and on the following day an excursion was organised for them by the Marine Ministry to Friederichsborg and Elsinore, which was fortunately favoured with fine weather.

THE SMOKE ABATEMENT INSTITUTE

AT a meeting held at Grosvenor House, under the presidency of His Grace the Duke of Westminster, K.G., on July 14, at which the Reports of the recent Exhibitions in London and Manchester were presented, and the medals distributed to successful exhibitors, the following resolution was moved by Prof. Abel, C.B., F.R.S., seconded by Mr. J. Norman Lockyer, F.R.S., and carried unanimously:—

"That it is desirable that the work thus far carried on by the Smoke Abatement Committee be continued, and for that purpose a Smoke Abatement Institute be formed."

The chief objects of the proposed Association will be:—

(*a*) To promote the abatement of coal smoke and other noxious products of combustion in cities and other places, in order to render the atmosphere as pure and as pervious to sunlight as practicable.

(*b*) To check the present serious waste of coal, and the direct and indirect loss and damage accompanying the over-production of smoke and noxious products of combustion.

Extended powers will be taken for carrying out the objects of the Association by the following, among other means, viz.:—

1. By promoting and encouraging the better and more economical use of coal and coal products, the selection of suitable fuel, and the general improvement in producing, applying, and using heat and light for domestic and industrial purposes.

2. By conducting tests of smoke-preventing apparatus and fuels in manufacturing towns as well as in London.

3. By reporting on tests, granting awards for approved fuels, methods, or apparatus; by lectures, printing, publishing, and circulating statistics and other information for the guidance of local authorities, inventors, manufacturers, and others; and by giving instruction to workmen, servants and others in the use of new appliances, &c.

The terms of membership are one guinea per annum, or such larger sum as members may voluntarily choose to contribute. No liability will be incurred by becoming a member beyond a guarantee of one guinea, payable, if required, in the event of the termination of the Association; and any member can withdraw from the Association by giving notice of his wish to do so.

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA[1]

IV.—*Degeneration*

THE cases already detailed lead us gradually up to the consideration of those very degenerate flowers whose structure has become completely debased, and especially of those which have green perianths instead of coloured corollas. As a rule, evolutionists have taken it for granted that green flowers were the earliest of any, and that from them the coloured types have been derived by insect selection. But if the principles laid down so far be correct, then it is obvious that, since all petals were originally yellow, green petals must be degraded, or at least altered types. Of course, the flowers of gymnosperms (in their blossoming stage) are mostly composed of green scales or leaves; and so it no doubt remains true that all flowers are ultimately descended from green, or greenish, ancestors. But if petals are by origin modified stamens, it will follow that all corollas at least were once coloured; and we shall probably see reason in the sequel to extend the principle to all perianths whatsoever. Without insisting upon the rule too dogmatically, so as to embrace every kind of angiosperm, we may, with some confidence, assert that wherever a flower possesses a rudiment of a perianth in any form, it is descended from coloured and entomophilous ancestors.

The Composites are, perhaps, in some respects, the very highest family of entomophilous flowers now existing on the earth. Their very structure implies the long and active co-operation of insect fertilisers. They could not otherwise have acquired the tubular form, the united corolla, the sheathed anthers, the compound heads of many-clustered florets. That originally green flowers could attain to this stage of development, and yet remain green, is simply inconceivable. But the Composites contain also some of the most degraded flower types in all nature. Beginning with such forms as the common groundsel (*Senecio vulgaris*), which has an inconspicuous yellow rayless head, specially adapted to self-fertilisation, we go on to plants like the *Artemisias*, with small greenish florets, which have taken, or are taking, to wind-fertilisation. Still more degraded are the *Antennarias*, *Gnaphaliums*, and *Filagos*, whose mode of fertilisation is problematical. And at the very bottom of the scale we get the little green *Xanthium;* so degenerate a form that its connection with the other Composites can only be traced by means of several intermediate exotics, in every stage of progressive degradation. Such conclusive examples clearly show us that green flowers may occur as products of degradation even in the most advanced families.

Adoxa moschatellina is another excellent specimen of a green corollifloral blossom. This pretty little plant is closely allied to the honeysuckles and ivies; but it has somehow acquired a light green corolla, in place of a white or pink one. It is still entomophilous, and scantily secretes honey, so that the reason of the change cannot be

---

[1] Continued from p. 350.

immediately pointed out. Perhaps its very inconspicuousness saves it from the obtrusive visits of undesirable insect guests. The flowers of *Hedera helix*, common ivy, are also yellowish green. In the allied family of *Umbelliferæ* many flowers have declined to similar greenish tints; but this can hardly be their primitive colour, as they have an inferior ovary, which marks high development. *Smyrnium olusatrum* in this family, and *Chrysosplenium* among the *Saxifragaceæ*, exhibit very well the steps by which green corollas or perianths may be produced from originally white or yellow flowers. Their high structural development obviously negatives the notion that they are primitive green flowers; and we must necessarily conclude that they have become green for some special functional purpose of their own.


FIG 27.


FIG. 28.

FIG. 27.—Single floret of *Poterium sanguisorba*, green and anemophilous. FIG. 28.—Single floret of *Sanguisorba officinalis*, purple and entomophilous.


FIG. 29.—Single blossom of South European *Fraxinus ornus*, flowering ash, with calyx and four-lobed white corolla.

The orchids themselves, that most specialised of entomophilous types, show us other examples of flowers which have become more or less green; such as *Malaxis paludosa*, which has a yellowish tinge; *Liparis loeselii*, also yellowish; *Epipactis latifolia*, greenish brown; *Listera ovata*, grass-green; *Habenaria viridis*, yellowish green; and *Herminium monorchis*, pale greenish yellow. Why these highly-developed entomophilous blossoms should have found green suit them better than white, pink, or purple, it would be hard to say; but the fact remains indisputable; and it would be almost inconceivable that flowers of so high a type should have remained green all through the various stages of their long previous development. We may confidently set them down as products of incipient degeneration.


FIG. 30.—Three forms of naked flowers of British ash, *Fraxinus excelsior*, without calyx or corolla.

Among polypetalous flowers we get some equally interesting facts. *Helleborus viridis*, a doubtfully English ranunculaceous plant, has small green petals, employed as nectaries, and concealed by the large green sepals. It is entomophilous, and much visited by insects. Instead of being one of the least-developed *Ranunculaceæ*, however, it is one of the most advanced and highly differentiated types. In the lily family, again, the onion genus (*Allium*) is a small, and often degraded, group, whose more retrograde members produce green in place of purple or white flowers. In *Allium vineale*, and some others, the flowers often degenerate so far as to become small caducous bulbs. Here, degeneration is the only possible solution of the problem presented by the facts.


FIG. 31


FIG. 32.

FIG. 31.—Single male flower of dog's mercury, green. FIG. 32.—Single female flower of dog's mercury, green.

More frequently, however, reversion to wind-fertilisation (probably the primitive habit of all flowering plants) has produced green blossoms among angiosperms. This may result in two or three distinct ways. Either the corolla may become dwarfed and inconspicuous, or it may coalesce with the sepals or calyx-tube, or it may cease to be produced altogether. We may take the plaintains (*Plantago*) as a good example of the first-named case. Here we have tubular florets with four corolla-lobes, apparently descended from some form not unlike *Veronica* (though with four cells to the ovary) but immensely degraded. The corolla is thin and scarious, and its lobes are tucked away at the sides, so as not to interfere with the stamens and style. These, again, as in most wind-fertilised plants, hang out freely to the breeze; so that the whole spike when flowering shows no signs of a corolla from without, but seems to consist entirely of scales, stamens, and styles, just like a sedge or


FIG. 33.


FIG. 34.

FIG. 33.—Cluster of male and female flowers of spurge, green, in a common involucre: the male flowers reduced to a single stamen each, jointed where the filament joins the peduncle. FIG. 34.—Male flower of nettle, green, the stamens opposite the sepals.

grass-plant. It is impossible, however, to examine the functionless corolla without coming to the conclusion that *Plantago* must be descended from an entomophilous ancestor. Indeed, *P. media* still to some extent lays itself out to attract small flies, by which it is even now often visited and fertilised.

The *Rosaceæ* offer some good examples of green flowers in which the petals have become quite extinct. Some of them are entomophilous, and some anemophilous. *Alchemilla vulgaris* (lady's mantle) is one of the former class. It is a degraded representative of the same group as agrimony; but it has lost its petals altogether. That it is a late, not a primitive form, is shown by its very reduced carpels, and its small number of stamens. *Alchemilla arvensis* (parsley-piert) is an extremely debased moss-like descendant of some similar ancestor. It has tiny green petalless axillary flowers, self-fertilised, but occasionally visited by minute insects. Not far from these may be placed *Poterium sanguisorba* (Fig. 27), another degraded type, which has become anemophilous. This flower, too, is green, and has no petals; it usually possesses but one carpel, and it is altogether a clearly debased bisexual form. Its stamens are numerous, and they hang out to the wind, so do also the feathery stigmas in the female flowers, to catch the pollen from neighbouring heads. But the closely-allied *Sanguisorba officinalis* (Fig. 28) is evidently an entomophilous variation on the same ancestral form; for it resembles *Poterium* in every respect except in its flowers, which have very few stamens, inclosed in the purple calyx-tube. This interesting case shows us that when a flower has once lost its petals and become anemophilous, it cannot re-develop them if it reverts to insect fertilisation, but must acquire a coloured calyx instead. The same lesson is perhaps elsewhere enforced by *Glaux maritima* among the *Primulaceæ*, and by *Clematis* among the *Ranunculaceæ*.

FIG. 35.

FIG. 36.

FIG. 37.

FIG. 35.—Female flower of willow, reduced to a scale and an ovary. FIG. 36.—Male flower of willow, reduced to a scale and two stamens. FIG. 37.—Naked flowers of the Arum, each consisting of a single ovary or a few naked stamens.

FIG. 38.—Single flower of *Acorus*, with three sepals, three petals, six stamens, and an ovary.

Mr. Darwin remarks that anemophilous flowers never possess a gaily-coloured corolla. The reason is clear. Such an adjunct could only result in the attraction of stray insects, which would uselessly eat up the pollen, and so do harm to the plant. Hence, when flowers rever to wind-fertilisation, both disuse and natural selection cause them to lose their petals, and become simply green.

In practice, however, it is often hard to distinguish between the casually entomophilous, the self-fertilised, and the really anemophilous species; and they are so intermixed that it may perhaps be best to consider them together. For example, the common ash (*Fraxinus excelsior*) belongs to a gamopetalous family, the *Oleaceæ*, and is closely related to the white privet (*Ligustrum vulgare*), which has conspicuous white flowers. But many large trees, owing, perhaps, to their long life, and consequent less necessity for producing many seeds, tend to lose their petals; and this is remarkably the case among the olive group. The shrubby species have usually flowers with a four-lobed corolla; and so have many of the southern arboreal forms (Fig. 29); but the northern trees, like our ash, have lost both calyx and corolla altogether, each naked flower consisting only of two stamens, with a single ovary between them (Fig. 30). In appearance their blossoms seem of much the same sort as the wind-fertilised catkins and oak-kinds. Nevertheless, they are entomophilous, for their pollen, their arrangement in large masses, and their dark purple colour, sufficiently serve to entice numerous insects.

FIG. 39.

FIG. 40.

FIG. 39.—Flower of *Scirpus*, a sedge, with hypogynous bristles representing the calyx and corolla. FIG. 40.—Flower of a grass, with calyx removed, showing two lodicules or rudimentary petals, three stamens, and an ovary with two stigmas.

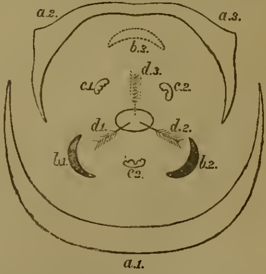


FIG. 41.—Diagram of grass flower, showing its relation to a lily: *a*, the calyx, represented by a_1, the flowering glume or outer palea, and a_2 and a_3, the inner palea, composed of two connate sepals; b_1 the corolla, represented by b_1 and b_2, the lodicules, b_3 the third petal, being obsolete; c_1 the stamens; d_1 the pistil, d_1 and d_2 the existing stigmas, d_3 being obsolete. The whole flower is thus abortively developed on the inner side next the axis.

The spurges (*Euphorbiaceæ*) are a very interesting family of the same sort, exhibiting every gradation from perfect corolliferous blossoms to the most degraded flowers in all nature. Our English species have no true petals; but some exotic forms are truly dichlamydeous;

and from them we can trace a gradual decline, through plants like dog's mercury (*Mercurialis perennis*), which has a green calyx, but no corolla (Figs. 31 and 32), to very degenerate green blossoms like our own spurges (*Euphorbia*), which consist of several extremely simplified flowers, collected together in a common involucre. Each separate male floret is here reduced to a single stamen, raised on a short peduncle, and with a distinct joint at the spot where the petals once stood (Fig. 33). It is worthy of notice, too, that when these degenerate, but still entomophilous, green flowers have found it desirable to attract insects by developing new coloured surfaces in place of the lost corolla, they have not done so by producing a fresh set of petals, but have acquired coloured bracts or involucres instead, as in the well-known *Iatrophas* and *Poinsettias* of our hot-houses. This instance is exactly analogous to that of the *Sanguisorba*. It tends to show that petals are not developed from bracts, but from altered stamens.

From cases like these we go down insensibly through all the ranks of the dicotyledonous *Monochlamydæ*. In the *Paronychiaceæ*, for example, we get an order closely allied to the *Caryophyllaceæ* (especially to *Polycarpon*); and in one genus (*Corrigiola*) the flowers have small white petals, which certainly aid in attracting insects. But in *Herniaria* the flowers are quite green, and the petals are reduced to five small filaments, thus partially reverting to their presumed original character as stamens. In *Scleranthus* the filaments are often wanting, and in some exotic species altogether so. The *Amarantaceæ*, unrepresented in Britain, approach the last-named family very nearly, but have the petals altogether obsolete; and in many cases, such as Prince's feather (*Amaranthus hypochondriacus*) and Love-lies-bleeding (*A. caudatus*), the calyx becomes scarious and brightly coloured. The *Chenopodiaceæ* are other near relations, in which also the petals are quite obsolete; and in most of them the perianth (or calyx) is green. In *Salicornia* it has become so embedded in the succulent leafless stem as to be almost indistinguishable. The *Polygonaceæ*, on the other hand, are a group of plants, allied to *Chenopodiaceæ*, but with a row of degraded petals, and a strong tendency to produce coloured perianths, analogous to that which we observed in *Sanguisorba*. The flowers of *Rumex*, the docks, are sometimes green, sometimes red; those of *Polygonum* are pale-green, white, or pink. *Rumex* is sometimes, *Polygonum* constantly, fertilised by insects.

There remain doubtful, then, among green Dicotyledons, only the highly anemophilous families, like the nettles (*Urticaceæ*), and the catkin-bearing trees (*Amentiferæ*). The former have a well-developed calyx, at least to the male flowers (Fig. 34), and it is difficult to see how any one who compares them with *Scleranthus* or *Mercurialis*, known descendants of petaliferous forms, can doubt that they too are degenerate types. Indeed, the mere fact that the stamens are opposite to the lobes of the calyx, instead of alternate with them, in itself shows that a petal-whorl has been suppressed; as is likewise the case in the goose-foots and many other doubtful instances.

As to the *Amentiferæ*, *Cupuliferæ*, and other catkin-bearers, at first sight we might suppose them to be primitive green anemophilous orders. But on closer consideration, we may see grounds for believing that they are really degenerate descendants of entomophilous plants. In the alder (*Alnus*) the male catkins consist of clustered flowers, three together under a bract, each containing a four-lobed perianth, with four stamens within. These little florets exactly resemble, on a smaller scale, those of the nettle; and the stamens here, again, are opposite to the calyx-lobes, which of course implies the suppression of a corolla. In the beech (*Betula*) the three florets under each bract are loosely and irregularly arranged; and in the male hornbeam (*Carpinus*) and hazel (*Corylus*) the perianth is wholly obsolete. All these are probably quite anemophilous. The willows (*Salix*), on the other hand, have become once more entomophilous (Figs. 35 and 36); and they are much visited by bees, which obtain honey from the small glands between the florets and the axis. Degenerate as these last-named species undoubtedly are, they may be connected by a regular line of illustrative examples (not genetically) through the beech, alder, nettle, goosefoot, *Scleranthus*, *Herniaria*, and *Corrigiola*, with such perfect petaliferous types as the pinks, and ultimately the buttercups.

Among Monocotyledons, the very degraded little entomophilous flowers of the *Arum* (Fig. 37), enclosed in their green spathe, are often spoken of as though they represented a primitive type. In reality, however, they are degenerate dichlamydeous blossoms, linked to the lilies by *Acorus* (Fig. 38), which has numerous hermaphrodite flowers, each with a perianth of six scales, two rows of stamens, and a two-celled or three-celled ovary. Here, again, the green flower is obviously of late date.

What, then, are we to say about the anemophilous Monocotyledons, the great families of the sedges and grasses? Surely these, at least, are primitive green wind-fertilised flowers. Dogmatically to assert the contrary would, indeed, be rash with our existing knowledge; yet we may see some reason for believing that even these highly anemophilous types are degenerate descendants of showy petaliferous blossoms. For, if the origin here assigned to petals be correct, it becomes clear that the *Juncaceæ*, or rushes, are only *Liliaceæ* in which the perianth has become dry and scarious. Some rushes, such as *Luzula*, approach very closely in general character to the grasses; and they also show themselves to be higher types by the further development of the ovary, and the decreased number of seeds. *Eriocaulon* and the *Restiaceæ* give us a further step towards the grass-like or sedge-like character. Some of the *Cyperaceæ* show apparent relics of a perianth in the bristles which surround the ovary, especially in *Scirpus* (Fig. 39); and perhaps the perigynium of *Carex* may represent a tubular perianth, though this is far more doubtful. In the grasses (*Gramineæ*) the perianth is either altogether obsolete, or else is reduced to the paleæ with the hypogynous scales or lodicules (Fig. 40). According to the most probable view, the two paleæ represent the calyx (for the inner palea exhibits rudiments of two sepals, thus making up, with the outer palea, a single trinary whorl); while the lodicules represent two of the petals, the third (the inner one) being usually obsolete (Fig. 41). It is fully developed, however, in the bamboo. The connection is here less clearly traceable than in the *Amentiferæ*, but it is still quite distinct enough to suggest at least the possibility that even grasses and sedges are ultimately derived from entomophilous flowers.

Thus we are led, at last, to the somewhat unexpected conclusion that anemophilous angiosperms are later in development than entomophilous angiosperms, and are derived from them. Though the earliest flowering plants —the pines, cycads, and other gymnosperms—were undoubtedly anemophilous from the first, yet the probability seems to be that all angiosperms were originally entomophilous, and that certain degenerate types have taken later on either to self-fertilisation, or to fertilisation by means of the wind. Why this apparently retrograde change has proved beneficial to them it would be impossible properly to inquire here. We must content ourselves with noting that such degraded green flowers fall for the most part under one or other of four heads: (1) dwarfed or weedy forms; (2) submerged or aquatic forms; (3) forest trees; (4) grass-like or plaintain-like plants of the open wind swept plains. That there are *no* primitive families of green or anemophilous angiosperms, it might perhaps be rash and premature to assert; but at least we may assume as very probable the principle that wherever green flowers possess any perianth, or the relic or rudiment of any perianth, or are genetically connected with perianth-bearing allies, they have once possessed coloured insect-attracting corollas. In short, green flowers seem always (except in gymnosperms) to be the degenerate descendants of blue, yellow, white, or red ones.

GRANT ALLEN

THE INSTITUTION OF MECHANICAL ENGINEERS

THE town of Leeds is this year the place of the summer meeting of the above institution. This meeting, which commenced last Tuesday, has brought together a large number of engineers from all parts, who received a cordial welcome from the Mayor and a local committee, and have already gone through the greater portion of a very interesting programme. The president's address, as well as the papers read in the mornings, not less than the varied nature of the works thrown open in the afternoons, show the increasing connection of the engineer with the progress of civilisation and the comforts of daily life. Perhaps no better example of this could be found than in the town of Leeds. It is not necessary, and certainly it would not be very easy, to detail all the varied productions of Leeds, in which the engineer now plays an indispensable part. One or two interesting instances may, however, be cited from one of two papers read, to show to what extent manual labour is being replaced by the application of machinery.

As late as 1857 nearly all the clothing in Leeds was hand-made. At the present time a machine like a band-saw, but with a knife-edge, is employed to cut out the clothes. Some twenty-five pieces of double-cloth laid on each other are thus cut out at once. The parts are then sewn at the rate of from 700 to 2000 stitches a minute, and finally are ironed by a machine. Indeed, the several processes of cutting out, sewing together, binding, braiding, putting in sleeves, sewing on buttons, making button-holes, and ironing, are all done by machinery. The result is that between three and four million garments are annually made in Leeds alone. In the hat and cap industry, machinery is very largely used, the production being as much as 70,000 dozen per week. The manufacture of boots and shoes is carried on almost entirely by machinery, and though each boot passes through the hands of from six to twelve persons, such an article can be completely made in half an hour, from one to two million pairs of boots are being thus annually produced. The saving of manual labour, as seen by the above facts, presents a striking contrast to its waste as shown in the gigantic structures of the East; but, as the President in his address remarked, there is a reverse to the medal. The smoke nuisance yet overshadows much good work (in few places more than in Leeds), when it is admitted that it is altogether inexcusable, and cannot be too severely dealt with. Science and art have practically overcome it; and experience enables many to assert that money can be profitably laid out and yield good interest in the abatement of this unpardonable nuisance. It is to be hoped that one result of these meetings will be to do all that is possible that posterity may *not* "assuredly lay its finger upon the great blot of waste, and stigmatise our age as the Black Age, which has spoilt by careless, unnecessary, and selfish emissions of smoke and noxious gases, many a noble town and many a lovely spot on earth."

H. S. H. S.

PROFESSOR HAECKEL IN CEYLON[1]

AFTER a fortnight devoted to the enjoyment of all that was new and strange in life in Ceylon, a fortnight fruitful in result to so shrewd and ardent an observer of nature and mankind, Professor Haeckel betook himself in earnest to the real object of his journey and looked about for the most favourable spot at which to conduct his zoological investigations. These were to be confined to that class of animal life which has been the object of Professor Haeckel's special study, namely, the Radiata, including star-fish, jelly-fish, etc, as well as corals, madrepores and other polypi. He hoped to make acquaintance with many new forms developed under the varying conditions of climate and coast formation and his letter in the August number of the *Rundschau* opens with a brief and succinct account of what these conditions are: "The conditions under which marine animals arrive at their fullest development are numerous and peculiar and it is by no means a matter of indifference what portion of the sea-coast we select for our investigations. The various qualities of sea water, its saltness, purity, temperature, rate of current and depth, must all be taken into account; and no less important, in fact often more so, is the nature of the neighbouring shore; whether it is rocky or sandy, barren or fertile and what is its geological formation. Then again, the amount of fresh-water drainage at any particular point, and the greater or less force of the waves have an important influence on the development of the marine fauna. For the classes in which I am more particularly interested: the Radiolites, Medusæ, Siphonophoræ, etc. the most favourable conditions are a deep, land-locked bay of clear still water, undisturbed by the influx of any great volume of fresh water and having strong currents setting towards the shore. Such a combination of favouring circumstances exists, for instance, in the Bay of Messina, the Gulf of Naples and other parts of the Mediterranean shore, long the chosen resort of zoologists. A glance at the map of India will show that such protected bays are of far rarer occurrence along its coast than on the many limbed and deeply indented shores of our glorious Mediterranean. The coast of Ceylon is provided with three only: the two beautiful harbours of Galle and Belligemma on the S. West coast and the magnificent isle-dotted Gulf of Trincomalee on the N. East. This last, Nelson declared to be one of the finest harbours in the world. The English government, quick to see the natural advantages of its dependencies and liberal in turning them to account, lost no time after the acquisition of Ceylon in forming Trincomalee into a fortified and well appointed harbour, by strengthening the forts already erected by the Dutch and by promoting in other ways the prosperity of the town. Much still remains to be done to make Trincomalee worthy of its position as the strongest harbour of refuge along the whole Indian coast. In the struggle in which England is sure sooner or later to be engaged for the possession of her Indian empire, this place will have an important part to play."

To so favourable a spot for the prosecution of his researches, the Professor naturally turned with a longing eye, but the difficulties of the long journey from Colombo to Trincomalee were insurmountable. There is no railway beyond Kandy, and from thence the journey must be made in bullock carts over bad roads and through thick forests. The season too was unfavourable; the heavy rains of the south-west monsoons having swelled the streams and carried away some of the bridges. The carts containing the sixteen chests of instruments, etc., necessary to the Professor's existence, would most assuredly have either stuck fast altogether or only arrived after much delay and with damaged contents. Nor were there any better prospects of a passage by sea. The little steamer usually forming the most direct means of communication for all places on the coast was laid up at Bombay for repairs, and the risk and uncertainty of sailing boats could not be thought of. With much regret, therefore, Professor Haeckel abandoned the idea of Trincomalee, and there only remained for him to decide between Galle and Belligemma. It is a proof at once of his ardour and

---

[1] Continued from page 275.

sincerity as a man of science that his choice finally fell on the latter. In leaving Galle he turned his back upon civilisation, upon intercourse with fellow-zoologists and upon all the aid which would have been afforded to him by the works of those who had preceded him in similar studies there. But the charm of exploring hitherto untrodden fields of discovery, of pursuing his studies in undisturbed solitude, and, we suspect, of dispensing with the dress-coat, which appears to have been a weight on his mind in all his intercourse with Anglo-Indian society, turned the scale in favour of Belligemma, a little fishing village, inhabited by 4000 Singhalese, without a solitary European among them. Nor had he reason to regret his choice. "The six weeks," he says, "which I spent in Belligemma were overflowing in impressions of beauty which I shall never lose, and are among the most delightful of my Indian memories. I might have found Galle a better and more convenient place for my special zoological purposes, but it could not have been nearly so rich in materials for enriching my views of nature and mankind in general."

Many preparations were necessary for a lengthened stay in so solitary and primitive a place as Belligemma. In the first place, permission had to be obtained from the Governor, Sir James Longden, for the Professor's residence in the Rest-House, since a stay of a few days is all that is usually allowed in these official substitutes for hotels.

The permission was of course, readily granted, and the Professor digresses to give a few words of strong commendation to the order and regularity which everywhere follows British rule, and to the practical good sense with which the Home government varies its mode of dealing with its colonies according to their requirements and idiosyncracies. Ceylon, for instance, is independent of the Indian government, and immediately under the control of the Colonial Minister in London; the Governor is virtually supreme, and seldom has recourse to the decisions of his purely deliberative parliament. It is customary to ascribe to this despotism, so averse to the English nature in general, most of the grievances which affect the prosperity of the island; but better reflection seems to show that a colony containing two and a half million inhabitants, among whom not more than 3,000 are Europeans, requires the concentration of power in a single hand, and that a truer ground for complaint is the Governor's short tenure of office, four years barely sufficing to make him acquainted with the needs of the island and its inhabitants.

Prof. Haeckel's next care was to provide himself with letters of introduction for his stay in Galle, *en route* for Belligemma, and having made all necessary purchases, to see his sixteen chests securely packed on a great two-wheeled bullock cart which was to occupy a week on the road between Colombo and Galle. Bullock carts form the only means of transit for heavy goods in those parts of Ceylon which are provided with roads. The large ones carry as much as forty hundredweight, and are drawn by four humped oxen or zebus. The waggon is a babarous two-wheeled contrivance, with a covering of plaited cocoa-nut leaves, and the weight has to be carefully disposed so as to throw the centre of gravity exactly over the axis of the wheels. Hundreds of such carts, some with two, others with four oxen are thus employed along the roads connecting the towns of Ceylon.

On December 9th, Prof. Haeckel left the hospitable Whist Bungalow, accompanied by the hearty good wishes and judicious counsels of his host and other friends. His description of the journey from Colombo to Galle is graphic and interesting; we must confine ourselves, however, to one or two points, which seem most likely to interest English readers, who may perhaps be already familiar with the main points of a journey so often described. A railway now takes the place of the old carriage road for about one third of the whole distance. The line keeps close to the coast, traversing the palm woods in a direction almost due south and ending at Caltura. The continuation of the line from Caltura to Galle, which would be of the greatest advantage to the latter place, has not been sanctioned by the government from the apprehension that Galle would thereby be enabled to compete with Colombo as the chief town of the island. The intercourse between the two towns is very lively and constantly increasing, so that of the commercial success of the railway no doubt could be entertained. Unhappily, the persistent desire to elevate Colombo to the prejudice of Galle has influenced the Government to refuse a concession to the company that was able and willing to find the capital for the undertaking.

"This action and its motive is the subject of much and very general complaint. Travellers have no resource but either to hire a very expensive private carriage, or to trust themselves to the 'Royal Mail Coach' which makes the journey daily between Caltura and Galle; but this is also very dear and far from comfortable. . . . . The most trying part of this coach journey and of all similar journeys in Ceylon is the cruel torture to which the unhappy horses are subjected. The Singhalese appear to have no idea that driving is an art which does not come by nature; nor that any process of education or 'adaptation' is necessary to prepare horses for going in harness. On the contrary, they appear to think that the whole affair is one of intuition, and that the knowledge of how to pull is hereditary in horses. Without any previous training the unhappy animal is fastened to the carriage by a very clumsy and imperfect harness, and then tortured with every variety of ingenious device, until, in sheer desperation, he sets off at a galop. . . . . The Holy Inquisition itself was not more fertile in resources for bringing heretics to repentance; and as I sat on the box-seat for a quarter of an hour or longer at a time, I often wondered for what sins these unhappy animals could thus, with any justice, be punished. It is possible that similar conjectures arose in the minds of the black coachman and conductor, who no doubt professed Siva worship, and believed in the transmigration of souls. Perhaps they thought that by inflicting these tortures they were avenging themselves on those cruel princes and warriors who once oppressed their people. Either some such idea as this, or their total want of sympathy with the sufferings of animals (perhaps, too, that curious belief existing in some parts of Europe that animals have no feeling), must account for the fact that the Singhalese regard the torturing of horses and oxen as a kind of amusing pastime. The arrival of the mail coach, and the changing of the horses is the great event of the day at every village, and all the inhabitants turn out to watch the proceeding with eager curiosity, to inspect and criticise the passengers, and to take an active part in the torturing of the freshly harnessed horses. When despair at last induces the animals to take flight, they rush in headlong galop, followed by the yells of the assembled crowd, until their breath fails and they fall into a slower pace for about half an hour, when, covered with sweat, with foaming mouths and trembling limbs, they halt at the next station, and are released for a time from their sufferings. It need hardly be said that this mode of travelling is neither pleasant nor devoid of risk to the traveller who trusts himself to the mercies of the Mail Coach driver. The coach itself is often upset and broken to pieces; the terrified horses spring suddenly to one side, or push the coach backwards into a banana bush or a ditch. I was always careful to be ready for a spring from my perch on the box seat. It is scarcely credible that the English government, usually so solicitous for order and discipline should have allowed this cruel treatment of horses to continue so long, and not have taken steps for its repression, at all events as far as concerned the horses of their own 'Royal Mail Coach.'

"The general character of the landscape varies very little during the whole long stretch of seventy miles between Colombo and Galle, but for all that the eye never tires. The constant charm of the cocoa woods, and the endless variety of the groups of palms prevent any sense of monotony. The glow of the tropical sun is tempered by a cool sea breeze, and by the shade of the palms. It is true, that their feathery foliage does not afford so thick and refreshing a shade as that of our northern forest trees; but very often the slender stems of the palms are covered with a lovely tangle of climbing pepper-wort, and other creepers, which hang in graceful festoons of thick foliage from crown to crown, many of them with blossoms of brilliant hue, such as the flaming *gloriosa superba*, the rose-red Bougainvillea and gay-coloured papillonaceous plants of different kinds. Here and there among the palms stand other trees, such as the noble mango, and the bread-fruit tree, with its thick dark green crown of leaves. The pillar-like stem of the graceful papaya tree (*Carica papaya*), is beautifully inlaid and adorned with a regular diadem of broad, hand-shaped leaves. Different kinds of jasmine, of orange and lemon trees are thickly covered with fragrant white blossoms. And nestling among the trees are the neat white or brown huts with their picturesque surroundings; one would seem to be driving through one long continuous village of palm gardens if one did not occasionally come upon a denser region of forest or upon a real village with its closer row of houses and country bazaar or market place. The road turns frequently towards the sea, and sometimes actually skirts the rocky coast. Here tracts of soft level sand alternate with rocky hillocks picturesquely clothed with the curious pandanus or screw pine. The cylindrical stem of this tree, seldom more than from twenty to forty feet in height, is bent and twisted, and its branches are forked or extended at right angles like a chandelier. Every branch bears at its extremity a thick bunch of large sword-shaped leaves (like the Daacaenæ and the Yucca). Some of the leaves are sea-green, others of a darker shade, all gracefully curved and with a spiral twist at their base, which gives the branch very much the appearance of a screw. At the base of the whole bunch of leaves hang white clusters of blossom with a marvellous perfume, or large red fruit very like the Anana. But the tree is chiefly remarkable for its numerous delicate air-roots, which are given off from the stem and ramify downwards in many directions; when they reach the ground they take root and serve to support the weak stem. It looks as if the tree were walking on stilts, as it rises above the lower brushwood, pushing its way between the cleft rocks of the shore, or creeping along the ground at their base. The white sand composing the level tracts of the shore is diversified with dark, rocky headlands and animated by brisk little sand crabs so nimble in flight as to have earned the classic name of Ocypode. Numerous hermit crabs too, (Pagurus) wander with a more leisurely pace among their swift-footed cousins, and bear with much dignity the snail shells which protect their soft and sensitive hind-quarters. Here and there sand-pipers, herons, plovers, and other shore birds, are busily employed in catching fish, in formidable competition with the Singhalese fishermen. The latter pursue their calling, some singly, others in companies, in which case they go out in several canoes with enormous nets which they all draw to shore together. (The members of the fisher caste are all Christians, having renounced their Buddhist faith in order to be able to take the life of the fish without deadly sin.) The single fishermen catch their prey by preference in the foaming surf. It is amusing to see the naked brown figures, with only a broad-brimmed straw hat to protect them from sunstroke, spring boldly into the waves and catch the fish in a little hand net. They appear as much in their element in the cool sea water, as do their little children who sport in troops along the shore and swim to perfection at six or eight years old." Among the beauties of this most beautiful journey, Prof. Haeckel further enumerates the river Deltas, of which there are many on this part of the coast, their dark forest of mangrove trees giving the landscape a deeper tone; and also the extensive lagoons which (especially between Colombo and Caltura) connect the rivers of the coast with each other. The Dutch took so much delight in these watery roads as reminiscences of their fatherland, that they formed them into a regular canal system to the neglect of the land roads. Numerous little trading boats sailed along the lagoons from place to place and formed their principal means of communication. But since the English have constructed their present excellent roads, the water traffic has almost ceased.

"The lagoons, with the thick bamboo and palm woods of their shores, with the lovely little islands, and rocky groups mirrored in their bosom, afford to the traveller a succession of enchanting pictures, especially where groups of slender cocoa palms tower over the dark green woodland masses, forming as Humboldt says: 'a forest above the forest.' The long range of hills in the blue distance forms a suitable background, higher mountain summits beyond rising here and there, and the stately dome of Adam's Peak towering over all."

NOTES

JUST three weeks after the sad death of Prof. Balfour, science has sustained another great loss in the death of Mr. W. Stanley Jevons. He was drowned in the sea between St. Leonard's and Bexhill, on Sunday morning, while bathing. He and his wife and family had been staying at Cliff-house, Galley-hill, for the last five weeks. Mr. Jevons was only in his forty-seventh year. Further details we must reserve for next week.

THE death is announced of Prof. Leith Adams, M.A., of the Queen's College, Cork. Entering the Army in 1848 as assistant surgeon, he became Surgeon-Major in 1861. His report on the Maltese cholera epidemic of 1865, and his devotion to the sick, received warm praise. He ultimately retired from the army in 1873 with the rank of Deputy Surgeon-General, and was appointed Professor of Zoology in the College of Science in Dublin, holding the chair till 1878, when he became Professor of Natural History in the Queen's College Cork. He was made a Fellow of the Geological Society in 1870, of the Royal in 1872, an LL.D. of Aberdeen in 1881, and a D.C.S. of the Queen's University a few weeks before his death. His chief works are the "Wanderings of a Naturalist in India," the "Western Himalayas and Cashmere" (1867), "Notes of a Naturalist in the Nile Valley and Malta" (1870), "Field and Forest Rambles, with Notes and Observations on the Natural History of Eastern Canada" (1873), and his "Monograph on the British Fossil Elephants" (1877).

A SCHEME for obtaining in a more effectual manner than hitherto a complete Annual Record of published scientific work is to be brought before the British Association this year by Prof. Sollas, of University College, Bristol. It requires (1) that each nation furnish a record of its own work, and of that only; (2) that each nation receive the records of every other nation in exchange for its own. Each nation would then merely have to classify and translate the records. For the working out of the scheme (*a*) National Committees, and (*b*) an International Congress would be required. The Committees, each consisting of a number of sections, would have, as functions, to produce the national records, to receive and transmit exchanges, to arrange for translations, and to superintend the combination of the separate records into a whole. The International Congress should consist of representatives of each of the Committees; and it would aim at securing so much uniformity as would be necessary for the successful working out of the scheme without interfering with the liberty of the Committees; it would also afford an opportunity for the interchange of ideas. Such a Congress might indeed be made a part of an International Association for the Advancement of Science. The scheme presents certain difficulties, especially that of expense, but these will doubtless be fully discussed by the Association when the subject is brought forward.

PROF. PRESTWICH has prepared "An Index Guide to the Geological Collections in the University Museum, Oxford" (Oxford: Clarendon Press), which is of a more general nature than the late Prof. Phillips's "Notices," and includes the large local collections, with regard to which he not only shows the various genera existing at each period, but gives the names of places where the fossils are to be met with. In the series of organic remains the student is enabled to follow the succession of life forms from the earliest palæozoic periods to the present; and in general, the relative place of the specimens in systematic classification and geological age is indicated.

A TELEGRAM from the Swedish Circumpolar Expedition party dated August 6, was received in Stockholm on the 11th inst. *viâ* Tromsö, where it had been brought by a Norwegian fishing smack; the Expedition has been unable to land on account of ice in Mossel Bay, and has in consequence returned to Cape Thordsten on the Norse islands, where the party landed, erected magazines and an observatory, and where observations are now being made. The message states "all well."

IT is noteworthy that Bossekop, one of the Polar stations selected this year for establishing an observatory, has before been occupied by a French scientific mission, sent in 1838 in *La Recherche*. The mission was composed of MM. Lottin, Bravais, and Charles Martin. They sailed in 1838 for Bossekop, where they stayed from September 1 of that year till April 30, 1839. This Polar exploration was followed by observations taken on Mont Blanc. The French North Polar Expedition was sent by the Government in connection with another directed to the Southern Polar seas, and conducted by Dumont d'Urville, who left Toulon on September 7, 1837, with the *Astrolabe* and the *Zeta*. This time English and American expeditions are sent to these remote and dangerous regions.

INTELLIGENCE received at Buenos Ayres, on July 15, announces the wreck at Cape Horn, of the vessel with Lieut. Bove and the members of the Italian Antarctic expedition on board. Lieut. Bove and his companions were saved by the English cutter *Allen Goden*.

ON Monday the annual Congress of the German Anthropological Society began at Frankfort. After an opening address by the President, Prof. Lucae, on the development of anthropology during the last ten years, Dr. Schliemann delivered a lecture on his latest excavations at Troy. He was followed by Prof. Virchow, on Mr. Darwin's relations to anthropology. About 500 members were present.

DR. MACKINTOSH, Superintendent of Murthly Asylum, Perthshire, has been presented by the patron, the Marquess of Ailsa, to the Natural History Chair in the University of St. Andrew's, vacant by the transfer of Prof. Nicholson to Aberdeen.

THE Trustees of the Gilchrist Educational Trust have arranged for courses of "Science Lectures for the People" during the ensuing winter in five towns of Central Lancashire, in five Scotch towns, and in Leicester, Lincoln, Chesterfield, Doncaster, York, Reading, and Banbury. The lecturers who will take part in them are Dr. Carpenter, F.R.S. (the Secretary to the Trust), Prof. Balfour Stewart, F.R.S., Prof. W. C. Williamson, F.R.S., Dr. Martin Duncan, F.R.S., Rev. W. H. Dallinger, F.R.S., and others.

WE learn from the *Photographic Times* (U.S.) that the third Annual Convention and Exhibition of the Photographers' Association of America was to meet at Indianapolis on the 8th inst. Mr. Muybridge, who has returned to America, purposes giving a series of lectures this autumn on instantaneous photography and what it has revealed.

CONCERNING the August meteors, Mr. Donald Cameron writes us from Aberfeldy, under date August 7, that there was a bright display the previous night witnessed by him from the right bank of the Tay. The meteors were many and brilliant, some of them comparing favourably with stars of the first magnitude; but they were very transient and left no traces of light. One of the longest in duration was one shot down at right angles to the horizon from a point equidistant from Saturn and the fifth bright star in Auriga. The region north of the Milky Way (which was bright and well defined) was the principal theatre of the display. At midnight the meteors became very rare, and Mr. Cameron waited till 1 a.m., seeing scarcely any. He remarks on the striking apparent proximity of the stars to the earth in those clear mountainous regions, the brightness of the moon, though, in her last quarter, on the night in question, and the silence of the owls which had been very noisy for some weeks before.

MR. STANFORD has published a Map of the Seat of War in Lower Egypt, on the scale of two miles to the inch; it is exceedingly clear, and likely to be of service to those desirous of watching the progress of operations

THE several designs presented to the Commission for the large dome of the Paris Observatory are being exhibited in the Museum of Astronomy established by Admiral Mouchez. The Commissioners have given the first prize to the design sent in by MM. Cail, of Paris.

M. DUVAUX, the new French Minister of Public Instruction, was formerly director of Nancy College. Since M. Jules Simon resigned, it is the first time that this high office has been given to a professor. This circumstance is considered as being important at a time when public bodies are showing such an interest in the cause of general and special education.

THE brickwork of the subterranean chambers of the Observatory of Paris, constructed for magnetic observations, is now quite finished. Admiral Mouchez intends to use a part of it, in order to study the changes of a mercurial reflecting surface, produced by the attraction of celestial bodies. The changes will be observed with a collimator watching the motion of the reflected image. The determinations will take place in an underground corridor, of which the length is upwards of forty yards and may be considered as being of invariable temperature.

A FIRE, caused by an electrical wire at the Paris Opera House, has created quite a sensation in the scientific world, although it has been successfully kept from the knowledge of the public. Mr. Geoffroy, a wire manufacturer in Paris, has taken a patent for covering electric wires with asbestos. Experiments, which will be repeated officially have proved that the copper can be burned without any spark being conducted outside. Another fatal accident from a similar cause occurred last week in Paris. Two young people wishing to introduce themselves into the Tuileries Gardens without paying th entrance-fee to a fair, came in contact with the wire conducting the electricity of a Brush machine to the lamps, and were killed instantly.

PROF. MAGGI has recently made a protistological analysis of the water of Lake Maggiore, taken at a depth of about 200 feet between Angera and Arona. There is a proposal, it is known, to supply Milan with potable water from this source. No injurious *bacteria* or *flagellata* were detected. The small deposit, probably from the bottom of the lake, is pronounced innocuous; it consists partly of harmless inorganic matter in reduction, and incapable of further evolution. The few diatom scales in it are harmless, being pure silica. The very small number of live organisms, as an *Amœba radiosa*, Auerb., some Diatoms, and *Chlorococcum vulgare*, Grév., indicate that the water is pure; for otherwise their life would be impossible. The Diatoms and Chlorococcum, feeding on inorganic matter, cannot serve as criteria of the presence of putrescible substances. These organisms were always found alive, even several months after extraction, so that their presence in small quantity could not be very hurtful; still it would be well to purify the water containing them. In fine, Prof. Maggi pronounces the water in question serviceable for industrial and domestic use. (For further details of this research we must refer to the *Rendiconti* of the Reale Istituto Lombardo, vol. xv. fasc. ix., x.).

IN an article on Foreign Chinese Literature the *North China Herald*, in a recent issue, refers to the translation of modern scientific works into Chinese. In May, 1877, a Committee of the general body of missionaries in China was appointed to superintend the publication of a series of scientific and educational works in the Chinese language for use among the Chinese. This project has been carried out ever since, and a large number of text-books are now undergoing translation at the hands of Sinologues. The majority of the workers are missionaries, but their ranks have been largely recruited from other sources. The subjects undertaken are of a most comprehensive nature. They include treatises on logic, mental and moral philosophy, political economy, philology, jurisprudence, the philology and structure of plants, anatomy, mathematical physics, church history, meteorology, astronomy, chemistry, trigonometry, algebra, natural philosophy, zoology, ethnology, mineralogy, physical and political geography, history, besides other works. The undertaking of this large and important series of works reflects the highest credit on the industry and intelligence of the missionary body. But the work of putting the Chinese in possession of the results of Western knowledge has not been confined to the missionaries. The Inspector-General of Chinese Customs, Sir Robert Hart, who is known as an indefatigable educator of the Chinese, is now superintending the translation of a series of scientific text-books into the Chinese vernacular. The Imperial College at Peking is assisting in the work.

A MEETING of Japanese *literati*, versed in European, Chinese, and Japanese languages, was recently held in Tokio. Among those present were the officers of the education and other departments, who regret the confusion and intricacies of the Japanese spoken and written languages. The object of the meeting was to consider the best steps to be taken for purifying the Japanese language from all foreign elements. After a lengthy discussion it was decided to publish grammars and other books in *Kana*, or the syllabary system, without the employment of Chinese characters. A periodical is also to be devoted to the furtherance of this scheme. The project seems a visionary one. The Chinese element in the Japanese language is a very ancient and powerful one. All Japanese philosophy, much of its religion, its arts and sciences, have come from China, and have brought their terminology with them. Even at the present day, when the Japanese want a name for western inventions, for steam, railways, &c., they go to China for them. Not many years since, a Japanese gentleman, who has since risen to a high position in the service of his country, gravely proposed the abolition of all kinds of Japanese and Chinese writing, and the application of Latin letters to the Japanese language. This reform is more radical than that now proposed, but it would seem almost as easy of accomplishment.

WE have received from New South Wales an interesting Report of the Trustees of the Australian Museum for 1881. This Museum is open on Sundays, when the attendance is very large indeed. The total number of visitors was 115,655, being an increase of 3192 on the number for 1880. The number who attended on Sundays was 41,660, being an increase of 8963 on the number for 1880, while the attendance on week-days decreased by 5771. The average daily attendance on week-days was 281, and on Sundays 801. The collections made during the dredging excursion to Port Stephens in November, 1880, were in some orders and families very extensive, but they have not yet been entirely worked out. The crustacea have been determined by Mr. Haswell, and the mollusca by Mr. Brazier. The vertebrates are all well known species, excepting some small deep-sea fishes. Most of the specimens were obtained within Port Stephens itself; and, with some differences in detail, they represent a fauna very similar to that of Port Jackson. The total number of species (invertebrata) procured may be roughly estimated at 700. Of these the mollusca, chiefly of minute kinds, comprise 450 species (1500 specimens), forty-seven of which are new to science. There were obtained also many fine specimens of sponges, of species hitherto unrepresented in the Museum. Among the corals there are several rare species, and some are new. Many other important additions have been made to the Museum. Among the collections purchased have been many very valuable ethnological specimens from the South Sea Islands, of a kind which it is daily becoming more difficult to obtain. A collection of fishes from New Guinea was also purchased. The Trustees are about to publish a Catalogue of the Crustacea of the Australian Seas. This work has been prepared by Mr. W. A. Haswell, M.A., B.Sc., and will be of great scientific value, containing, as it does, descriptions of all known Australian species, many of which are new to science. A Catalogue of the collection of fossils has also been prepared. Both of these will shortly leave the printer's hands. Mr. Brazier has been engaged in cataloguing the collections of shells. The most important work undertaken by the Trustees during the year has been the renewal of the exploration of the caves of the Colony; for which object a special sum of money was voted by Parliament. The bones obtained there are all of recent origin, belonging to still existing species of the kangaroo, wallaby, wombat, opossum, &c. The Siluro-Devonian fossils, however, obtained from the limestone rocks are of considerable interest, and will form a valuable addition to the Museum collection. In one of the caves at Wellington, known as the Breccia Cave, above 1000 specimens were obtained, many of them of great interest; among others an almost perfect ramus of a Thylacoleo with the articulating condyle; and the toe bones of a large species of Echidna. In another cave the tooth of a Diprotodon and some bones of small marsupials were found. In some other shafts the bones were larger and more perfect than those in the Breccia Cave. Among the most important discoveries were portions of the pelvis of an immense kangaroo, caudal and cervical vertebræ; jaws of large marsupials, especially five rami of Thylacoleo nearly perfect, and many good teeth. A list of the most important specimens discovered is contained in the Appendix.

WITH regard to the doctoring of wines by the process known as *plâtrage* (*i.e.* adding plaster of Paris, or calcium sulphate, which decomposes the potassium tartrates, producing sulphate of potassium, and preventing much of the astringent and colouring matter from passing into solution), the Canton of Berne in September, 1879, issued an ordinance, fixing as an upper limit for potassium sulphate in wines so doctored, 2 grammes per litre. Various complaints then arose from merchants, who thought the regulation too stringent; and the Direction of Internal Affairs nominated a Commission, consisting of Herren Lichtheim, Luch-inger, and Nencki to study the subject afresh. In their report (*Journal für Prakt. Chem.*) they come to the conclusions (1) that the perniciousness of plastered wines even when they contain more than 2 gr. sulphate of potassium per litre, is far from being demonstrated indisputably. On the other hand it remains proved that wines strongly plastered have sometimes caused slight accidents, and it results from our theoretic study that the prolonged use of such a drink cannot be without prejudice to health; (2) that we therefore do not think it well to leave the trade in plastered wines without any control. While recognising the difficulty of fixing an absolute limit for plastering, they approve as sufficient that of the ordinance in question; on the one hand, it guarantees the public against illness from use of wines too much plastered, and on the other it is not a heavier fetter for the producer than similar prescriptions in France, where the interest in tolerance of plastered wines is vastly greater. Each buyer who has ordered a natural wine should have the right to refuse any wine containing more than 0·6 gr. neutral sulphate of potassium per litre. The reporters are unable to answer a question as to the action of plastered white wines on the system as compared with red.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. F. Logie Pirie; two Silver Pheasants (*Euplocamus nycthemerus*) from China, presented by Mrs. Hames; a Peregrine Falcon (*Falco peregrinus*), European, presented by Col. A. Brooksbank; a Peregrine Falcon (*Falco peregrinus*) captured at sea off Ceylon, presented by Mr. Tom Broune; six Common Kingfishers (*Alcedo ispida*), British, presented by Mr. T. A. A. Burnaby; two Slow-worms (*Anguis fragilis*), two Common Vipers (*Vipera berus*), British, presented by Mr. Charles Taylor; a Moustache Monkey (*Cercopithecus cephus*) from West Africa, two Common Ravens (*Corvus corax*), British, two Common Boas (*Boa constrictor*) from South America, deposited; two Shags or Green Cormorants (*Phalacrocorax cristatus*), European, purchased.

CLIMATE IN TOWN AND COUNTRY[1]

THE speaker began by describing the construction and uses of the instruments with which he had studied the conditions of climate, for many years past, in various parts of Europe. For the determination of sun temperature, he used a thermometer technically known as the blackened bulb *in vacuo* laid in full sunshine upon a sheet of white paper. The shade or air temperature was measured by an ordinary thermometer with a clear glass bulb and a scale engraved upon the stem. This thermometer was placed upon the same sheet of paper, and was shaded by a small white paper arch which admitted of a free circulation of air around the bulb.

He then explained the terms "sun temperature," "shade temperature," and "solar intensity." By shade temperature is meant the temperature of free air in full sunshine. Strictly it ought to be ascertained without any shade at all; for as soon as a shade is produced, conditions are introduced which often entirely baffle the object of the observer. The shade of a parasol has a different temperature from the shade of a tree, and this, again, differs widely from that of a house. The temperature of the shade of a sheet of tinfoil is quite different from that of a sheet of writing paper. Indeed it may be truly said that every shade has its own peculiar temperature. The following table shows the effect of the area of shade, and of the quality of the shading material:—

Beneath larch tree	19°·5 C.
,, white parasol	25·0
,, small white paper arch	35·0
,, small arch of bright tinfoil ...	45·2

Thus shade temperatures, measured during 1¾ hours of uninterupted sunshine in the middle of the day, and within a few yards of the same spot, differed by no less than 25°·7 C. These observations were, however, made at Pontresina, 5,915 feet above the sea-level, and so wide a range does not occur at lower altitudes.

The most effective shading material is, obviously, that which most perfectly reflects solar heat; and of all materials with which he had experimented white paper was found to be the best, white linen and zinc-white being nearly equal to it. The most trustworthy shade thermometer, therefore, is one having its bulb covered with a thin layer of one of these materials; or the naked layer may be shaded by a small arch of white paper.

The term "sun temperature," as commonly employed, has a very vague meaning. If a body could be placed in sunlight under such circumstances as to absorb heat rays and emit none, its temperature would soon rise to that of the sun itself. But, as all good absorbers of heat are also good radiators, the elevation of temperature caused by the exposure of even good absorbers to sunlight is comparatively small. Thus an isolated thermometer, with blackened glass bulb, placed in sunshine, will rarely rise more than 10° C. above the temperature which it marks when screened from direct sunlight. Under these circumstances, however, the thermometer loses heat not merely by radiation, but also by actual contact with the surrounding cold air. If the latter source of loss be obviated, a much higher sun temperature is obtained. Thus, the blackened bulb enclosed in a vacuous clear glass globe will sometimes, when placed in sunlight, rise as much as 60° C. above the shade temperature, and a still higher degree of heat may be obtained by exposing to the sun's rays the naked blackened bulb of a thermometer enclosed in a wooden box padded with black cloth, and closed by a lid of clear plate glass. Thus he obtained with such a box, on the 22nd of December, in Switzerland, when the air was considerably below the freezing point, a temperature of 105° C., and a still higher temperature could doubtless be obtained by surrounding the thermometer with a vacuous globe before enclosing it in the padded box. These widely different temperatures, produced under different conditions by the solar rays, show that such observations can be comparative only when the thermometer employed to measure them is always surrounded by the same conditions. All the sun temperatures here mentioned were measured when the "blackened bulb *in vacuo*" was laid horizontally upon a sheet of white paper with its stem at right angles to the direction of the sun's rays.

"Solar intensity" is relative only, and means the number of degrees through which the sun raises the temperature of a blackened bulb *in vacuo* over the shade temperature. Hence the two temperatures must be observed simultaneously, which is a laborious operation when continued half-hourly throughout the day. By the use of a peculiar self-registering differential thermometer, however, which he had recently described to the Royal Society (*Proceedings* of the Royal Society, 1882, p. 331), the maximum solar intensity during the day is recorded by one reading only. The solar intensities commented upon in this discourse were ascertained by subtracting, in each case, the shade temperature from the sun temperature taken synchronously. The precautions necessary are described in the paper to the Royal Society just quoted.

The chief things affecting climate are the following:—(1) The sun. (2) Land and water—ocean and atmospheric currents. (3) Aspect—slope of ground, exposure or shelter. (4) Nature of surface. (5) Reflection from land and water. (6) Rain and clouds—suspended matter in the air. (7) Latitude—incidence of solar rays, thickness of air. (8) Presence or absence of aqueous vapour. Of these, the first three are obvious and require no comment. The remainder are less well known, but their importance demands our special attention.

Climate, or rather genial climate, is ultimately resolvable into two prime factors—sun-warmth and air-warmth. The amount of sun-warmth (assuming the sun's heat to be constant) depends upon two things only—length of day, and quantity of suspended matter and aqueous vapour in the air. The warmth of the air depends upon contact with matter heated by the sun's rays and upon the stoppage of radiation from the earth by aqueous vapour.

---

[1] Lecture delivered at the Royal Institution of Great Britain, February 10, 1882, by E. Frankland, Esq., D.C.L., F.R.S., M.R.I., Professor of Chemistry in the Normal School of Science, South Kensington Museum.

This heated matter is :—(1) Sea or land. (2) Suspended matter in the air—cloud, dust, smoke. (3) Aqueous vapour.

These two factors were first considered in their relation to

COUNTRY CLIMATE

The feeling of warmth and comfort in the open air is produced either by direct solar radiation, even if the air be very cold ; or by the warmth of the air itself. Upon both of these, the nature of the surface upon which the sunlight falls has a paramount influence, as is seen from the results of experiments on sun temperature recorded in the following table :—

INFLUENCE OF SURFACE

Norway.

Green grass	57°·3 C.
Parched grass	61·2
Bare soil	60·6
Newly-mown grass	56·5
White paper	73·5

Hesse Cassel.

Black caoutchouc	54°·7 C.
Black silk	56·5
Plane glass mirror	64·0
Slightly concave metallic mirror	64·0
Green grass	58·5
White paper	67·7

Switzerland. Mortaratsch Glacier.

Black caoutchouc	39°·0 C.
Bare white ice	47·5
White paper	53·0

Summit of Gornergrat.

Dazzling white snow	59°·0 C.
White paper	61·2

Pontresina.

White paper	66°·2 C.
Grass	54·0
Grey rock	54·0
Black caoutchouc	56·4

Diavolezza.

Black caoutchouc	39°·1 C.
Snow	61·9
White paper	65·8

Italy. Bellagio.

Black caoutchouc	60°·0 C.
Black merino	59·0
White linen	66·0
White paper	66.3

These results may be imitated with the powerful light from a Siemens' dynamo-machine. [Experiments shown.]

The warmth of the air over these surfaces was in the inverse order, caoutchouc heating the air most, white paper and snow least. The nearer the colour of the ground approaches to *white*, the more genial will be the climate from radiation and the cooler will be the air. The nearer it gets to *black*, the warmer will be the air and the less will temperature be due to radiation. Dark surfaces warm the air ; light surfaces keep it cool, but warm the body by radiant reflection. The difference is substantially the same out of doors as that produced indoors by a close stove on the one hand, and an open fire on the other ; but calm air is required for the enjoyment of radiant heat.

The sun's radiant heat may be greatly reinforced by reflection from surrounding objects. There are two kinds of reflectors ; those which, like white paper, white linen, and whitewash, scatter the solar heat in all directions, and those which, mirror-like, reflect it in one direction only. To the former belong snow, chalk, light-coloured sand, and light-coloured earth ; to the latter, water. The former are useful on whatever side they may be, the latter only when they are between the observer and the sun. The observations in the following table illustrate this effect of reflection from surrounding objects :—

INFLUENCE OF REFLECTION FROM SURROUNDING OBJECTS

From a white-washed wall. Pontresina.

On white paper 10 feet from wall	38°·7 C.
in adjoining meadow	27·7

From water. Top of cliff at Alum Bay, Isle of Wight.

Direct and reflected rays	31°·2 C.
Direct rays only	25·7

Zürich. One mile from Lake.

Direct and reflected rays	34°·0 C.
Direct rays only	31·5

M. Dufour has observed the same phenomenon on the lake of Geneva between Lausanne and Vevay. He has measured the proportions of direct and reflected heat at five different stations on the northern shore of the lake, and the results are condensed in the following table :—

DUFOUR'S OBSERVATIONS

Altitude of Sun.	Proportion of direct to reflected heat.
3° 34′ to 4° 38′	100 : 68.
7°	100 : 40 to 50.
16°	100 : 20 to 30.

When the sun was higher than 30° the reflected heat was hardly perceptible. Hence this reflection is of the greatest value in winter, when it is most wanted, and it also tends to equalise temperature during the day ; for in the early morning and evening, when the sun is low, and his direct heat is small, the reflected heat is greatest.

The bearing of these observations upon winter refuges for invalids is obvious. While the primary conditions to be secured must ever be fine weather and a sheltered position, the next in importance is, doubtless, exposure all day long to reflected, as well as direct, solar radiation. To realise this, a southern aspect and a considerable expanse of water or snow are necessary, and it is important that the sanitarium should be considerably and somewhat abruptly elevated above the reflecting surface, so that it may receive, throughout the entire day, the uninterrupted reflection of the sun's rays. At or near the sea-level, however, it is impossible, owing to solid and liquid matters floating in the lower regions of the atmosphere, to enjoy anything approaching to a uniform temperature from sunrise to sunset.

Although this suspended matter exists even at great altitudes, the bulk of it floats below 5,000 feet, and whilst only one-sixth of the atmosphere is below this height, there is probably much more than one-half of the suspended matter at a lower elevation. As might be expected, therefore, solar intensity is much greater at high than at low elevations, although the temperature of the air continually decreases as it is further removed from the earth's surface. The following tables contain observations illustrative of this point :—

SOLAR INTENSITY.

Station	Height of Barometer.	Sun's Altitude.	Indicated Solar Intensity.
	Inch.	°	°C.
Oatlands Park	29·9	60	41·5
Riffelberg	22·0	60	45·5
Hörnli	21·2	61	48·1
Gornergrat	20·5	61	47·0
Isle of Wight	30·0	58	42·3
Riffelberg	22·0	60	45·5
Piz Languard	20·2	54	45·8
Whitby	30·1	50	37·8
Pontresina	24·0	49	44·0
Bernina Hospitz	22·6	51	46·4
Diavolezza	20·8	50	59·5
Bellagio	29·3	47	39·8
Shiahorn	21·6	46	43·5
Schwarzhorn	20·3	46	45·5

SHADE TEMPERATURES AT NOON AND DIFFERENT ALTITUDES

Station.	Height above Sea. Inch.	Sun's Altitude. °	Temperature. °C.
Oatlands Park	150	60	30·0
Riffelberg	8,428	60	24·5
Hörnli	9,491	61	20·1
Gornergrat	10,289	61	14·2
Whitby	60	50	32·2
Aak, Romsdal	20	49	36·2
Pontresina	5,915	49	26·5
Bernina Hospitz	7,644	51	19·1
Diavolezza	9,767	50	6·0
Bellagio	700	47	28·5
Shiahorn	8,924	46	23·0
Schwarzhorn	10,338	46	20·5

Hence it follows that the difference of solar intensity between noon and sunrise and sunset respectively is less at great than at small elevations, a deduction which is substantiated by the experimental data contained in the following table:—

VARIATION OF SOLAR INTENSITY AT DIFFERENT HOURS.

Station.	Time.	Solar Intensity. °C.	Difference. °C
Isle of Wight	Noon	42·3	7·6
,, ,,	3·30 P.M.	34·7	
,, ,,	Noon	42·1	8·5
,, ,,	3.15 P.M.	33·6	
,, ,,	Noon	41.7	8·4
,, ,,	3.50 P.M.	33·3	
At Sea	8.30 A.M.	33·8	7·9
,,	Noon	41·7	
Riffelberg (8,428 ft.)	8.20 A.M.	40·9	4·6
,, ,,	Noon	45·5	
Gornergrat (10,289 ft.)	,,	47 0	5·3
,, ,,	3 P.M.	41·7	

Similar testimony is also afforded by a comparison of early and late observations at widely different altitudes:—

VARIATIONS OF SOLAR INTENSITY AT DIFFERENT ALTITUDES

Station	Time. A.M.	Sun's Altitude at Noon.	Height above Sea. Feet.	Solar Intensity. °C.	Difference °C.
At Sea	7·35	72	0	28·6	8·6
Riffelberg	7·45	60	8,428	37·2	
At Sea	8·8	72	0	30·3	10·6
Riffelberg	8.20	60	8,428	49·2	

The sun's altitude was unfavourable for the comparison; nevertheless, there were here observed differences of 8·6° C. and 10·6°.

The farther we recede from the earth, the nearer we realise the conditions of solar radiation altogether outside the limits of the atmosphere, where the solar intensity (assuming the sun's emission to remain constant) is uniform from sunrise to sunset. Throughout the dreary winter days, when, even in the country, a leaden sky oppresses us, it is tantalising to reffect that, at the moderate height of 5,000 feet, which can be reached by a balloon in a few minutes, there is probably blue sky and brilliant sunshine.

Latitude profoundly, though irregularly, affects air temperature, for in high latitudes less solar heat falls upon each square foot of the earth's surface, and therefore the air resting upon that surface is warmed to less extent. But obliquity of the sun's rays has no such influence on solar intensity, for the highest readings of solar heat at or near sea-level have been observed near to the Arctic circle, as is seen from the following table:—

SOLAR INTENSITY IN DIFFERENT LATITUDES.

Station.	Latitude. °	Sun's Altitude. °	Sun Temperature. °C.	Solar Intensity. °C.
At Sea	0	84	78·9	41·7
Oatlands Park	52 N.	61	75·0	45·0
Isle of Wight	51 ,,	58	72·3	42·3
At Sea	23 ,,	56	71·7	45·0
Cassel	51 ,,	53	68·7	—
Tosten Vierod	59 ,,	52	73·5	—
Whitby	54 ,,	50	67·8	36·8
Aak, Romsdal	63 ,,	49	82·5	48·7
At Sea	30 ,,	48	70·3	43·6
Bellagio	45 ,,	47	68·3	39·8

These results show that, with an obliquity of only 6°, the sun temperature and solar intensity were respectively only 78·9° and 48·7° C.; whilst with an obliquity of 41°, there were 82·5° and 48·7° C. *On the equator at noon, with a nearly vertical sun, the solar intensity was actually 7° C. lower than in Romsdal, only 4° S. of the Arctic circle.* On the other hand, air warmth diminishes, as a rule, with increase of latitude, although, as the following table shows, there are some remarkable exceptions, for it was 1° higher in lat. 52° N. with an obliquity of 29°, than in lat. 5° N. with an obliquity of only 12°, and in the high latitude 63°, with an obliquity of 41°, it was only 1° C in arrear of the air-warmth at the equator with an obliquity of only 6°.

SHADE TEMPERATURE AT OR NEAR NOON AND SEA-LEVEL.

Station.	Latitude. °	Sun's Apparent Altitude. °	Temperature. °
At Sea, April 10	45 S.	37	18·9
,, March 23	31 ,,	58	26·3
,, ,, 22	29 ,,	60	29·7
,, ,, 18	27 ,,	65	32·5
,, ,, 17	23 ,,	68	32·8
,, ,, 16	20 ,,	71	29·4
,, ,, 13	11 ,,	82	37·2
,, ,, 12	10 ,,	83	37·2
,, ,, 11	9 ,,	85	36·5
,, ,, 6	0 ,,	84	37·2
,, ,, 4	3 N.	81	30·0
,, ,, 3	5 ,,	78	29·4
,, ,, 2	8 ,,	75	31·7
,, Feb. 24	17 ,,	64	28·0
,, ,, 20	21 ,,	58	28·3
,, ,, 19	23 ,,	56	27·2
,, ,, 16	30 ,,	48	28·9
,, Jan. 27	51 ,,	21	10·6
Bellagio, Sept. 17	45 ,,	47	28·5
Oatlands Park, June 8	52 ,,	61	30·0
Isle of Wight, May 13	51 ,,	57	28·9
,, ,, ,, 14	51 ,,	58	29·0
,, ,, ,, 15	51 ,,	58	30·0
Whitby Aug. 16	54 ,,	50	32·0
Aak, Romsdal, July 15	63 ,,	49	36·2

Shortly summarised, therefore, the conditions most favourable for a genial climate—

Depending on solar intensity are—	Depending on air temperature, are—
1. Great elevation above sea-level.	1. Slight elevation above sea-level.
2. A light coloured ground and back-ground.	2. A dark coloured ground and back-ground.
3. Shelter. Reception of direct and reflected rays.	3. Shelter. Reception of direct and reflected rays.
4. A clear sun with white clouds.	4. A clear sun with white clouds.
5. A clean atmosphere. No dust, smoke, or fog.	5. A clean atmosphere. No dust, smoke, or fog.
6. A minimum of watery vapour in the air.	6. A maximum of watery vapour in the air.

Thus whilst there are three conditions common to both categories, the three remaining ones are diametrically opposed to each other.

TOWN CLIMATE.

The climate of towns depends upon the same essential conditions as that of the country, but some of these are more within our own control in towns.

The great evils of our town climate are excessive heat in summer and cheerless gloom in winter. We suffer less, however, from excessive solar intensity than continental cities between the same parallells of latitude, owing to the very causes which plunge us into a more miserable gloom in winter. Light-coloured walls neither make our streets look cheerful nor feel hot. Such sad colours as brick, stone, stucco, or paint give to our houses are soon changed to a grimy neutral tint, powerless to reflect either solar light or heat.

The darker the colour of the houses, the cooler the streets and the hotter the rooms during sunshine, and *vice versa*. Whilst the summer climate in our streets and houses is thus, to a considerable extent controllable, that of winter, which depends so much on a clean atmosphere, is still more so. All our towns are nearly at the sea-level, a position favourable for air-, but not for sun-warmth. In our large towns, however, we artificially create an impenetrable barrier to solar radiation by throwing into the air the imperfectly burnt products of bituminous coal.

These products are of three kinds—soot, tar, and steam. Every ton of bituminous coal burnt in our grates gives off about 6 cwts. of volatile but condensable products. The less perfect the combustion the more tar and the less steam will be produced. If perfectly burnt without any smoke, then about 9 cwts. of steam, occupying 27,359 cubic feet at 100° C., or 20,024 cubic feet at 0° C. will be sent into the air. Now, 33,333 tons of bituminous coal are, on the average daily consumed in London in winter, giving 667,460,000 cubic feet of steam at 0° C.

This combustion of enormous quantities of bituminous coal acts in the production of town fog in three ways:—1st. By supplying the basis of all fog—condensed watery particles. 2nd. By determining the condensation of atmospheric moisture in the form of fog. 3rd. By coating the fog particles with tar, and thus making them more persistent.

All fogs have for their basis watery particles, and the greater part even of the suspended matters visible in a ray of electric light consists of these particles, for the air becomes nearly clear when it is heated somewhat above 100° C. [Experiment shown]. Everything therefore which increases the proportion of aqueous vapour in town air tends to produce fog. But aqueous vapour alone would probably never produce fog, for it condenses at once to large particles, which rapidly fall as rain. When, however, solid or liquid particles are present in the air, the minute spherules of fog are produced. This was first shown by Messrs. Coulier and Mascart, in 1875, and their results have since been confirmed by Mr. Aitkin. The speaker showed that air filtered through cotton wool, though afterwards saturated with moisture, produced no fog when its temperature was lowered; but as soon as a small quantity of the dusty air of the theatre was admitted fog was immediately formed, whilst, when a little coal smoke was introduced, a dense and more persistent fog was the result.

The fog once formed is rendered more persistent by the coating of tarry matter which it receives from the products of the imperfect combustion of smoky coal. The speaker had made numerous experiments on the retardation of evaporation by films of coal tar. He had found that the evaporation of water in a platinum dish placed in a strong draught of air was retarded in one experiment by 84 per cent. and in another by 78·6 per cent., when a thin film of coal tar was placed on the surfaces. Even by the mere blowing of coal smoke on the surface of the water for a few seconds, the evaporation was retarded by from 77·3 to 81·5 per cent. Drops of water suspended in loops of platinum wire were also found to have their evaporation retarded by coal smoke. Hence arise the so-called dry fogs which have been observed by Mr. Glaisher in balloon ascents, some examples of which are given in the following table:—

FOG IN COMPARATIVELY DRY AIR.

Place of Ascent.	Altitude.	Temperature of Air.	Degree of Humidity.
	Feet.	°F.	100 = saturation.
Wolverhampton	5,922 ...	53·5 ...	61
Crystal Palace...	3,698 ...	38·5 ...	62
,, ,, ...	9,000 ...	32·5 ...	52
,, ,, ...	1,000 ...	64·7 ...	53
Wolverton	11,000 ...	30·0 ...	68
Woolwich	6,000 ...	44·0 ...	64
,, ...	4,400 ...	42·0 ...	52

Thus the smoke of our domestic fires constitutes a potent cause both for the generation and the persistency of town fogs. In London, at all events, if all manufacturing operations were absolutely to cease, the fogs would not be perceptibly less dense or irritating. Granting then this cause of town fogs, what are the remedies open to us? The speaker was of opinion that the substitution of a sufficient number of smoke-consuming grates (assuming a smoke-consuming grate to have been invented), for the 1,800,000 fire-places of London was quite hopeless, and that one remedy only could be of any appreciable service—*the importation of bituminous coal must be forbidden.* This is a case in which individual effort can do nothing; but State or municipal action would be simple and decisive.

There need be no fear that the price of smokeless fuel would rise inordinately, for the sources of this fuel are too numerous and inexhaustible to admit of either a monopoly or a serious rise in price. In addition to the enormous stores of smokeless coal in the Welsh coal-fields, every bituminous coal yields a smokeless coke, either in the retorts of gasworks or in coke ovens. On the average, 100 tons of smoky coal yields 60 tons of coke, the remaining 40 tons being driven off as combustible gas, ammoniacal liquor and tar; and as there is an almost unlimited demand for these products, it is not unlikely that they would, under the circumstances contemplated, repay the cost of coking, and it is worthy of note that coal of very inferior quality makes fairly good coke.

The only objection to the domestic use of smokeless coal and coke is the difficulty of lighting the fire, but this is obviated by the use of gas as proposed by Dr. Siemens. In ordinary grates, however, there is little difficulty in lighting and burning these smokeless fuels if the throat of the chimney be contracted so as to increase the draught. In this way nearly every grate in London could be rendered smokeless at an expenditure of a couple of shillings.

It is unnecessary to enumerate the many advantages of a smokeless atmosphere, but it may here be mentioned that London fogs not only seriously injure health but annually destroy the lives of thousands. In one week alone upwards of 1,100 lives have been thus sacrificed in London. We have doubtless still long to wait before the only remedy for London fogs will be adopted; but in the meantime, immunity from their effects, so far as the respiratory organs are concerned, may be obtained by the use of a small and very portable cotton-wool respirator which is made, in accordance with the speaker's directions, by Mr. Casella, of Holborn. [Respirator exhibited.] Armed with this little instrument, he had often passed through the densest and most irritating fogs with perfect immunity, breathing, in fact, all the time, air even purer than that of the country. Such a remedy is, however, obviously of extremely limited application.

In conclusion he said, though we may, with justice, complain of the scanty share of sunshine now received by us, let us not forget that, in our coal-fields, we are compensated by vast stores of the sunlight of past ages. How far through electricity, these stores can be evoked to supplement the present defective supply, he would be a bold man who would venture to predict. Let us not, however, continue to use this great legacy of light of the past to obscure the small one of the present.

SCIENTIFIC SERIALS

American Journal of Science, July.—Contributions to meteorology (seventeenth paper), by E. Loomis.—The phenomena of metalliferous vein-formation now in progress at Sulphur Bank, California, by J. Le Conte and W. B. Rising.—Modes of occurrence of the diamond in Brazil, by O. A. Derby.—On the influence of time on the change in the resistance of the carbon-disc of Edison's tasimeter, by T. C. Mendenhall.—Further observations on the crystallised sands of the Potsdam sandstone of Wisconsin, by A. A. Young.—On the origin of jointed structure, by G. K. Gilbert.—Break-circuit arrangements for transmitting clock-beats, by F. E. Nipher.—Cirriped crustacean from the Devonian, by J. M. Clarke.

Archives des Sciences Physiques et Naturelles, No. 7, June 15.—Contribution of astronomy to the solution of a problem of molecular physics, by M. R. Pictet.—Study of the variations of kinetic energy of the solar system, by MM. Pictet and Cellerier. Swiss Committee of Geological Unification, by M. Renevier.—On a characteristic of the Batatas, whose singularity in the family of the Convolvulaceæ has not been sufficiently remarked, by M. de Candolle.—Observation of Mr. Meehan on the variability of the English oak (*Quercus robur*), and remark by M. de Candolle.—Note on Echinida gathered in the environs of Camerino (Tuscany), by M. Canavari.

No. 7, July 15.—On the rotatory polarisation of quartz, by MM. Soret and Sarasin.—On the diffusion of bacteria, by M. Schnetzler.—Petrogenic classification or grouping of rocks according to their mode of formation, adopted for academic instruction and for the museum of Lausanne, by M. Renevier.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, July 13.—O. Tumlirz, on a method for researches on the absorption of light by coloured solutions.—G. Gruss and K. Koegler, on the orbit of *Oenone* (215).—I. Tesar, kinematic determinations of the outline of a warped screw-plane.—A. Wassmuth, on an application of the mechanical theory of heat to the process of magnetisation.—W. Fossek, on some new derivates of isobutylaldehyde.—H. Weidel and R. Brix, contribution to the knowledge of cinchonic and pyrocinchonic acid.—A. Freund, on trimethene.—I. v. Hepperger, computation of the way of the comet 1874 III. (Coggia).

PARIS

Academy of Sciences, August 7.—M. Blanchard in the chair.—The following papers were read:—Researches on the action of ethylenic chlorhydrin on pyridic bases and on chinoline, by M. Wurtz.—Employment of photography to determine the trajectory of bodies in motion, with their velocities at each instant and their relative positions; applications to animal mechanics, by M. Marey. A body brightly illuminated is set in motion before a dark screen, and its path photographed on a very sensitive plate. Thus M. Marey obtained the path of a stone wrapped in white paper and thrown in the air; such a stone whirled by means of a string; the same while a person walked forward; a black baton with terminal white ball, with which the author traced the letters of his name, &c. To indicate velocity, the light is interrupted (say) 100 times a second, by rotation of a spoked wheel; and to determine synchronism of motion of different parts of a moving body, one of the spokes is broadened to double the length of eclipse at intervals.—On the sensibility of the cerebral lobes in mammalia, by M. Vulpian. He is unable to confirm M. Couty's observation of movements provoked by mechanical stimulation of the grey cerebral cortex. He considers the substance of the cerebral lobes to have but little sensibility.—A note from M. Vaison, at Saint Denis (island of Reunion), stated that a comet was there seen on June 16 in the Crab, with nucleus comparable to a star of the second magnitude.—Remarks concerning the problem of Kepler, by M. Radau.—Observations of solar protuberances, faculæ, and spots at the Royal Observatory of the Roman College, during the first six months of 1882, by P. Tacchini. The oscillations of the protuberances, north and south, are regular and periodic; the period of oscillation is less manifest for the spots, and for the faculæ it fails entirely. Spots and faculæ present two maxima, between ± 10° and ± 30°, as in the last half of 1881; (the faculæ reach higher latitudes than the spots). The protuberances figure in all zones, and their maxima correspond to those of the faculæ and spots. The minimum of protuberances, observed in December, extended into January; then there was an increase till March. Another minimum occurred in May.—On the longitudinal vibrations of elastic bars, &c. (continued) by MM. Sebert and Hugoniot.—On the elasticity of rarefied gases, by M. Amagat. Having repeated his experiments with modified apparatus (especially the differential barometer), he affirms that down to the lowest pressures (and he reached two-tenths of a millimetre), there does not seem to occur a sudden change in the law of compressibility of gases. They still follow the law of Mariotte with little divergence.—On the influence of a quantity of gas dissolved in a liquid on its superficial tension, by M. Wroblewski. In contradiction of M. Kundt's theory, he finds that lowering the temperature, instead of retarding the decrease of surface tension, accelerates it. The phenomena are quite independent of pressure, and depend on the state of saturation of the liquid surface (or quantity of gas dissolved in the surface layer).—Numerical relations between thermal data, by M. Tommasi. When one metal is substituted for another in a saline solution, the quantity of calories liberated is, for each metal, always the same, whatever the nature of the acid forming part of the salt or of the halogen body united to the metal.—Researches on the telephone, by M. d'Arsonval. Various facts prove that the really active part of the wire is that lodged between the poles of the magnet; thus in the two-pole telephones, all the wire not between the poles may be considered useless resistance. He describes an instrument realising this idea; it transmits with great force and distinctness.—On the equivalent of iodides of phosphorus, by M. Troost.—Heat of formation of the principal palladium compounds, by M. Joannis.—Factitious purulent ophthalmia produced by the liquorice-liana (*Abrus precatorius*) or the jequirity of Brazil, by M. de Wecker.—Researches on chinoline and on lutidine, by M. Amé Pictet.—The vaso-dilator nerves of the ear, by MM. Dastre and Morat.—Researches on the pancreas of cyclostomes, and on the liver without excretory canal of *Petromyzon marinus*, by M. Legouis.—Direct observation of the motion of water in the vessels of plants, by M. Veigne. He describes microscopical observations on cut stems of *Tradescantia zebrina* and *Hartwegia comosa* verifying recent views of M. Boehm.—Simultaneous existence of flowers and insects on the mountains of Dauphiné, by M. Musset. Flowers and insects being never simultaneously and mutually wanting, Heckel's objection to cross-fertilisation on the score of absence or rarity of these auxiliary animals on flower-bearing summits loses all value.—M. Bigi presented a self-winding clock, depending on thermo-electric currents produced by variations of temperature.

BERLIN

Physiological Society, July 28.—Prof. Du Bois Reymond in the chair.—Dr. Saltet has, by a series of experiments in the Berlin Physiological Institute on frog's hearts that were traversed by different liquids, and placed in various baths, sought to determine the cause of their fatigue. It appeared that the carbonic acid formed by the heart-muscle in its action acts prejudicially to its nutrition and work; it diminishes the height and frequency of the pulse, so long as it is in contact with the muscle-fibres. On the other hand, fatigue of the heart does not occur, when, by strong contraction, the carbonic acid is separated from the muscle-fibres, and, mixing with the nutritive liquid, is carried away with it. For prevention of fatigue, moreover, those baths acted very favourably, into which the carbonic acid easily diffused, *e.g.* alkaline and ordinary salt-solutions; whereas, in an oil-bath which does not take up the carbonic acid, fatigue occurs very quickly, under like conditions. A heart fatigued in the oil bath, being brought into a salt solution, while the same nutritive liquid passed through, the fatigue disappeared, and the pulsations reappeared, probably because the carbonic acid could now diffuse away. Quite similar results were arrived at by Herr Joseph Denys by experiments on other involuntary muscles of the frog, whose contractions, with maximum stimulation, were indicated by the kymographion. It appeared from this investigation, also carried out under the guidance of Prof. Kronecker, that carbonic acid is the most probable cause of the diminished work, as the curves increased in height when, during rest, the muscle was traversed by liquids which could absorb the carbonic acid.—Prof. Kronecker reported finally on experiments by Dr. Wedenski, on the muscle tone in electric stimulation. The observations were made with a telephone, and showed an essential agreement between the number of the vibrations heard and the frequency of the electric stimuli. On voluntary contraction of his arm-muscles, Dr. Wedenski heard a deep humming tone, whereby, on the whole, the data of previous observers as to the pitch of the muscle-tone were confirmed.

CONTENTS

THURSDAY, AUGUST 24, 1882

TEXT-BOOKS OF ANATOMY

Handbuch der Vergleichenden Anatomie. Leitfaden bei Zoologischen und Zootomischen Vorlesungen. By Prof. E. Oscar Schmidt. Eighth edition, pp 327. (Jena, 1882.)

Lehrbuch der Vergleichenden Anatomie der Wirbelthiere auf Grundlage der Entwickelungsgeschichte. By Prof. Rt. Wiedersheim. First part, pp. 476. (Jena, 1882.)

IT is now thirty-three years ago since Oscar Schmidt, then a young Privat Docent, published the first edition of his "Handbook of Comparative Anatomy" as a guide to his course of lectures. Successive generations of students have called for successive editions, until in the present year the author is in the enviable position of issuing the eighth edition of his Handbook, and he has added to its value by now for the first time illustrating it with upwards of 100 well executed woodcuts. It would be out of place, and indeed quite unnecessary, to enter into a detailed criticism of a work, so well known as the present, and which has obviously supplied a want felt by so many students. As regards the general motive of the book we may say that it presents an outline of the comparative anatomy both of the Invertebrata and Vertebrata, written in a clear style and methodically arranged.

He classifies animals into eight groups: Protista and Protozoa, Cœlenterata, Echinodermata, Vermes, Arthropoda, Mollusca, Tunicata, Vertebrata. This classification will scarcely commend itself to the more ardent members of that school of zoologists, which bases taxonomy on embryology; and which considers no system of classification is of value unless it expresses the path that has been taken by animals in the course of their evolution. By these zoologists Prof. Schmidt's system will without doubt be regarded as old-fashioned. But it has the merit of simplicity, and this from the student's point of view is no slight recommendation. Moreover, taxonomic systems, more especially of the Invertebrata, based on supposed phylogenic relations, are as yet mere speculations. They have their value, no doubt, as grouping together certain ascertained facts, and as suggesting new directions for investigation. But they are in the main quite hypothetical, and without such fixity of knowledge as will give them permanent value.

There is one point in the classification of the Mammalia followed by Prof. Schmidt, to which we must take very decided exception. We refer to the adoption of the placenta as a dominant character in the subdivision of the Monodelphia. Milne-Edwards, Huxley, Haeckel, and Carus have all undoubtedly attached much importance to this organ in taxonomy, but from the fuller knowledge that we now possess, both of its form in various mammals and of the mode in which it is shed during parturition, it is clear that its characters are not of such primary value as to outweigh, in framing a system of classification, those furnished by the other organic systems. In placing the Prosimii (*Halbaffen*) amongst the *Deciduata*, Schmidt has committed a similar error to that into which Haeckel has also fallen. For the Lemurs, whose placentation has been carefully studied both by Alphonse Milne-Edwards in Paris and by W. Turner in Edinburgh, are unquestionably as *adeciduate* as a mare, a pig, or a whale. In the lemurs, as in these animals, the villi are diffused over the greater part of the surface of the chorion, and the sac of the allantois is relatively large. The evidence, therefore, is altogether opposed to retaining them in the position in which Schmidt has placed them amongst the deciduata. Again, he ranks the Edentata in the *Adeciduata*, but there is no uniformity in the character of the placenta in this order of mammals. In *Manis* undoubtedly it is non-deciduate and diffused; in *Orycteropus* it is broadly zonular; whilst in the Sloths it is deciduate and composed of numerous discoid lobes.

Prof. Wiedersheim's Lehrbuch differs from that of Prof. Schmidt in being limited to the comparative anatomy of the Vertebrata. It is a new candidate for public favour, and as yet only the first part has been published. In this part, after a short general introduction, the author treats in succession of the integument, skeleton, muscular, and nervous systems, including the organs of sense and electrical apparatus of the several classes of vertebrates. The modifications in the form and arrangement of the different systems are examined, therefore, rather in their anatomico-physiological than in their zoological aspects. By limiting himself to one only of the great divisions of the animal kingdom, the author has been enabled, within the compass of a volume of moderate size, to enter much more fully into the consideration of the several systems than was possible in Prof. Schmidt's treatise, and he has produced a work which, when completed, will be of service to those students who desire a fuller acquaintance with the details of vertebrate structure. For students of Human Anatomy this book will have a special interest, as the subject is treated so as to throw great light on the modifications of structure met with in other vertebrates when compared with man. The author indeed appears to have had in his mind, in planning out the work, the needs of students of medicine; and he has been desirous of giving to their anatomical training a wider and more philosophic range than it frequently possesses. The teaching of anatomy in our medical schools is unfortunately too much entrusted to men whose main object in life is the practice of surgery, and who follow anatomy for a time merely as a training for that practice. It becomes therefore in their hands a dry specialty. The varied and complex structures of the human body are regarded almost exclusively as parts which are liable to disease and injury, and which may require surgical interference, whilst the marvellous beauty of their physiological and morphological relations is ignored. When human anatomy is taught from a scientific, and not from a mechanical point of view, it becomes a medium for the exposition of the great facts and principles of development and morphology, and its value as an educational instrument is enormously increased.

We can recommend Prof. Wiedersheim's "Lehrbuch," both to students of medicine and to their anatomical teachers, as a work in which they will find a clear and concisely written description of the great facts of vertebrate structure; by the perusal of which much that may seem obscure in the construction of the human body will be illuminated, and great additional interest will be imparted to their studies. The book is copiously illustrated with well executed woodcuts, most of which are original, and have been specially prepared for the purpose.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

School Museums

IN the new instructions to inspectors as to the application of the New Code to Elementary Schools, it is stated that a Museum will be required in a school in order to make a school "excellent" under the "merit" clause.

I would suggest to your readers that here is an excellent opportunity for their employing the scientific knowledge they possess in promoting the study of nature in a very simple and easy manner. Let them offer first to instruct and interest teachers and pupil teachers in some one branch of knowledge—let it be botany, geology, or entomology. Let them show the teachers how to collect and press, say a dozen plants, help them to classify and name them, both in English and Latin, and let them teach say to the First Standard, what they know on the subject, making the children bring each plant after it has been shown. Even in town schools there will be some country friend who could send up two or three specimens every week in the spring and summer.

I would suggest that the discarded child school books will make herbaria, and convenient books for catalogues of specimens.

For a geological museum a small cupboard with, say in this neighbourhood, seven shelves, would hold two specimens from each of our prominent strata, Lower, Middle, and Upper Lias, the Midford, or as Mr. Witchell, of Stroud, wants to call them, the Cotteswold Sands, the Inferior Oolite, Fuller's Earth, and Great Oolite, all of which can be seen from this parish if the two higher beds are not actually in it. On the inside of the cupboard doors might be put, boldly coloured, sections of the strata. Geologists might greatly help in seeing that the names of the strata and specimens were correctly given and pronounced, and a catalogue written out. And if prizes were given to promote even the most elementary knowledge in teachers and scholars, much would be done to make "science subjects" interesting and useful.

I would suggest that natural history societies and field clubs should take this in hand in their own neighbourhoods, and by the expenditure of a very small sum of money start a natural history museum in every school. A. SHAW PAGE

Selsley Vicarage, Gloucestershire, August 17

Two Kinds of Stamens with Different Functions in the same Flower

IN NATURE, vol. xxiv. p. 307 is a very interesting letter on this subject, in which while the functions performed by the two kinds of stamens are very clearly indicated, the *modus operandi* of fertilisation, it appears to me, is less clearly expressed. I have witnessed in many instances the visitation by various species of large Hymenoptera, such as *Xylocopa* and *Bombus*, of species especially of the genus *Melastoma*, possessing stamens in all points corresponding to that occurring in the *Heeria* described in the letter referred to and what takes place seems to be as follows. The large bees evidently make for the yellow platform offered by the short stamens, perhaps because they do not perceive the pistil and long stamens owing to their projection against the broad petaled corolla of the same colour in the background, and invariably receive the pistil between their legs, their feet settling on the fork of the connective, the instant effect of which is to collect the whole of the long stamens into a bunch, and to depress their anthers downwards and away from the body of the visiting bee, while the pistil remains in constant contact with its ventral side. At the moment of the bee's departure the hooks on the bee's feet by pulling on the connective fork raise the anthers of the long stamens, so as to bring the tips of the collected bunch into contact with its sides and abdomen. Dr. Müller's statement "by moving the connective fork of the larger ones" is somewhat ambiguous; for it is movement only in one direction that is of avail in *raising* the anthers of the larger stamens, pressure at the connective hook of course tends to depress the anthers and keep them apart from the bee's abdomen while a very slight backward pull at once raises the anther.

In various observations and discussions arising out of this letter, both Dr. Burck (the assistant director of the Botanical Gardens in Buitenzorg) and myself were able to observe a fact of considerable importance that there was, at any rate in those species examined by us, a great difference in the pollen of the two kinds of anthers. The pollen from the short stamens was large and three-cornered, while that of the longer ones was very much smaller and of a more oval shape; and while both forms were found on the pistil, only the pollen from the long stamens seemed to be fertile. We could not detect any of the short stamened pollen with tubes ejected. HENRY O. FORBES

Wai, Amboina, May

Habit of Spiders

I HAVE frequently observed that when a shock of any kind is imparted to the leaves or twigs, to which the web of the garden spider is affixed, the animal shakes violently in the centre of the web, so as to become almost or totally invisible to the eye; this quivering or dancing motion being kept up for many seconds, and then suddenly stopped. The same thing occurs, I have noticed, when a stick is presented suddenly to the occupant of the web. The reason for these movements, which appear to be effected by the spider in succession pulling the upper portion of the web downwards by means of his strong hindermost pair of legs, and then suddenly releasing it (the natural elasticity of the web greatly assisting the occupier in the execution of these movements), seems to be founded upon a desire on the part of the spider to effect concealment when it feels that danger is near; just as we notice gnats and crane-flies dance rapidly up and down, evidently with the desire of rendering themselves invisible, whilst at rest on the window pane, trusting no doubt to their speedy flight and general invisibility for protection when on the wing. FRANK J. ROWBOTHAM

42, Loftus Road, Shepherds Bush, W., August 21

Messrs. McAlpine's Atlases

I DOUBT not but you will grant me the privilege of replying to the remarks made by Prof. Parker under the above heading in your last issue, and fortunately in doing so I will not require to trespass much upon your valuable space. The letter deals first with myself personally, then with the Atlases.

With regard to his reference to my student history, it may suffice to say that I had no connection with the Biological Laboratory at South Kensington *some three or four years ago.* I studied at the Royal School of Mines from 1872 to 1875, spending Session 1874-75 in the Biological Laboratory; but as to the alleged copying of diagrams of type dissections, how, I ask, was this possible when, as far as known to me, such drawings were not in existence.

Again, his statement as to my having presented myself for examination in the two following years, appearing each time a place or two lower in the second class is equally destitute of fact. I was re-examined in 1876 and 1878, but instead of appearing either higher or lower in the second class, I invariably stood at the bottom of it.

I need not dwell further upon a personal matter, and it will not be necessary, after the above explanation, to say much about the Atlases. The opinions expressed with regard to my work it is not for me to call in question, but will simply content myself with saying that it has been favourably commented on by journals—scientific and medical, at home and in the colonies—only one of which I quote. Prof. Parker speaks of my work as being "of the most inaccurate and slovenly description," while the *Canadian Journal of Medical Science* says: "The truthfulness, accuracy, and neatness which mark each of its pages compel us to speak in very high terms of this book."

Polwarth Gardens, Edinburgh, July 31 D. MCALPINE

ORANGE CULTURE IN FLORIDA.—A correspondent inquires for the best work on this subject; perhaps some of our readers may be able to answer.

THE "EIRA" EXPEDITION

AFTER the horrors of the *Jeannette* expedition, every one will be relieved to learn that on Sunday Mr. Leigh Smith and all his men were safely landed at Aberdeen in the *Hope*, under the care of Sir Allen Young. Sir Allen has not been long in attaining the object for which he set out, although the safety of the *Eira* expedition would have been secured, even had no help been sent from England, for when they reached Matotschkin Schar, they found both the *Willem Barents* and a Russian vessel. The scientific results of the expedition, we regret to say, are almost *nil*.

On June 14, 1881, the *Eira* left Peterhead. The ice reached very far south, and no opening could be found to enable her to get north until the middle of July. Franz Josef's Land was reached on July 23, and the *Eira* steamed along the coast to within fifteen miles of Cape Ludlow. The ice was closely packed to the north, so it was decided to return to Gray Bay and wait till a more favourable opportunity should present itself to proceed. On August 7 the *Eira* was made fast to the land-floe near Bell Island, and a storehouse was erected of materials taken out in the ship. On August 15 she left Bell Island, and, being unable to pass to the eastward of Barents Hook, she was made fast to the land-floe off Cape Flora. The next few days were spent in collecting plants and fossils, which unfortunately were lost with the vessel. On August 21 the *Eira* was heavily nipped by the ice, and about 10 a.m. a leak was discovered, and barely two hours elapsed till the vessel had to be abandoned. All the boats were saved, and most of the men saved some clothes and bedding.

The tent was ultimately erected on Cape Flora, and here the expedition spent the winter, making the best of their circumstances. But little food had been saved, and the party had therefore to keep a sharp look out for walruses, bears, and other native game, on which they lived, and on which, along with a daily drop of rum, they maintained their health, according to the report of the surgeon. There were one or two cases of illness, but no trace of scurvy, though 70° of frost were at times experienced. In June the ice was cleared away, and on the 21st four boats were started from Cape Flora, with twenty-five men and provisions for six months. The *Eira* men were more fortunate than the discoverers of Franz Josef Land in their escape; for although they had sometimes to drag their boats over the ice, they reached Novaya Zemlya, at Matotschkin Schar, on August 2. Next day they were sighted by the *William Barents*, and as Sir Allen Young, in the *Hope*, was only a mile away, Mr. Leigh Smith and his men were soon welcomed on board the steamer sent to rescue them.

When Mr. Smith publishes his detailed narrative, we may find that he has been able to make some addition to a knowledge of the geography and natural history of the region where he has wintered, though we fear it cannot be much. All his collections went down with the *Eira*, so that science cannot be a great gainer by his expedition. Until details are to hand, it is impossible to say whether the catastrophe to the vessel could have been avoided, or whether it was one of those accidents for which all Arctic explorers must be prepared. The ice seems to have been in motion very early this year for that region, and we know that it has come down unusually far south; any information concerning the movements of the ice in high latitudes during the past spring and summer would be welcome.

The following is an interesting extract from the journal report upon Cape Flora (obtained by the *Times* Aberdeen Correspondent), giving an account of the birds, bears, and walrus seen during the winter spent there:—

"On July 25, 1881, we reached Gray Bay, at Cape Grant and Cape Crowther. There are large loomeries a short distance up the bay on the water side. Many rotgees had their young among the basaltic columns of the lofty cliffs. Other birds were also seen, including the snow bird, the molly, the boatswain, the Arctic tern, dovekies, the eider duck, the burgomaster, and the kittiwake. At the east side, near the head of Gray Bay, there were a good number of snow birds and dovekies building, but too high up for one to obtain the eggs. At Cape Stephen there was a large loomery, and at Cape Forbes there were a few looms, a good number of rotgees and dovekies, and some snow birds. At Bell Island the same species of birds were seen, and on the south side there was a large loomery and nests of kittiwakes, dovekies, rotgees, snow birds, and burgomasters. Rein-geese and brent-geese were seen and shot on the cliffs 700 feet high, but no nests were seen. At Cape Flora there was a very large loomery, and also many rotgees, dovekies, kittiwakes, and snow birds. On the lowland several snow buntings and sandlings were seen, but no nests were found. The looms lay their eggs on the bare rock, and the dovekies and rotgees lay them in the crevices of the rocks. The kittiwake makes a nest of mud and moss. The snow bird makes a rudimentary nest of moss and feathers, but of no definite shape. Each species seems to occupy a separate part of the cliff. The rotgees and dovekies left about the first week in September. Looms were very scarce after September 10. On September 22 a few burgomasters, snow-birds, mollies, kittiwakes, eider ducks, and brent-geese were seen, but getting very scarce. One or two snow buntings still remained on the land on October 13. Three or four snow birds, and occasionally a burgomaster or molly were seen hovering around outside the hut which had been erected, and on October 28, while we were killing some walrus, two snow birds, two or three mollies, and burgomasters were seen, and remained for two or three days eating the refuse of the carcases. On February 8 a snow owl was seen. This was the first bird to arrive. On February 18 two or three flocks of dovekies were seen following to the north-west, and on the 20th there were a great number seen in the water. On March 2 a lane of water was made close to the land-floe, and it was filled with rotgees and dovekies. On March 9 the first loom was seen, but it was not until the end of March that they began to settle on the rocks, and then they would only stop on the cliffs for a few hours and go away for four or five days. We were not able to get up the hill to shoot any until April 16. On April 20 the first snow bird was seen. A falcon hawk appeared on April 22, on which day two burgomasters were also seen. On April 24 the molly was seen. On May 6 the kittiwakes came. It was not until about June 10 that the looms remained on the rocks for more than two or three days at a time, but after that date the females began to take their places ready for laying the eggs, and on June 20 three eggs were obtained. Foxes were constantly troubling us during the winter, coming right up to the door after blubber, and would only run a few yards away when anybody went out to drive them off. We were obliged to shoot some at last as they became almost tame. Bears were more numerous while we had the water close outside the land ice. They would come walking along the edge of the land ice, and when they got scent of the house would walk right up to it. During the dark we killed four or five every month, except November, but we saw on an average two a week. One moonlight night in November there were five or six bears within 400 yards of the house, but we could not get a shot at any of them unless we kept very still until the bear came up to the house. We never shot a female bear from October to March 13. This is an important fact. They were always very large male bears. Several times on examining the contents of the stomach we found them full of nothing but grass; but in the spring they generally had been feeding on seals, and more than once we obtained a good bucketful of oil for cooking purposes out of the bear's stomach. Once a bear had eaten a large piece of greasy canvas which had been thrown away and had been blown some 200 or 300 yards from the house. He then came up to the house and commenced to eat our blubber, but was immediately shot. On February 20 a bear was seen about 350 feet above the hill at the back of the house. Some hands went up with a rifle and found that the bear had a hole there, out of which they could not get it—fortunately for them, as they had only one rifle with them, and that would not go off, the lock having been frozen. We never saw any young bear with it. The last time the bear was seen at its hole was on March 1. No track of a bear could be traced up the hill, but the foot-marks of an old bear and a cub were seen on the low land, about 300 yards to the eastward of the house. No old she-bears with young cubs were seen before we left the land in June. In July, 1881, on nearing Cape Crowther, walrus were seen lying on loose pieces of ice in great numbers. Sometimes twenty or more were counted huddled up in a heap on a small piece of ice. By going quietly in a boat you could get within twenty or thirty yards of them before they took much notice of you, but after the first shot was fired they tumbled into the water, and would go swimming about and barking round the boat, but never attacked us. In September they were very numerous on the loose ice round Bell Island, and also in the water off Cape Flora. On October 28 five were shot lying on the ice edge. When the daylight returned in February, walrus were constantly seen swimming about in the water. A land floe began to form in March, and no water remained within seven or eight miles of the land, but frequently on looking with the glass from the hill, walrus could be seen in the water, and on June 13 the land ice broke away, and on June 15 the five walrus were shot. A boat that went over to Bell Island reported that walrus were lying in scores on the loose ice round about Bell Island. Mr. Leigh Smith thinks that the walrus leave the country during the winter, but seem to remain in the water, especially if it is shallow. They never saw any signs of their taking the land and lying up for the winter. White whales and narwhal were seen in great numbers in September and October travelling to the south-east, and in June one or two large shoals were seen travelling west and west-north-west."

PROFESSOR HAECKEL IN CEYLON[1]

IV.

PROF. HAECKEL, in describing his first impression of Galle, does not fail to mention as one of its principal features the long lines of shady Suriya trees and flowering Hibiscus, planted by the Dutch, and giving the streets the appearance of a garden. He says nothing, however, of a plague produced by the Suriya, and noted by other travellers, namely, the hairy green caterpillar, which frequents it in great numbers. At a certain stage of its growth it drops to the ground, and there hides in order to pass through its metamorphosis. When, as often happens, it alights on some passer-by, it inflicts a sting more severe and far more lasting than that of a nettle or star-fish.

The professor found himself, as might have been expected, a welcome guest to all the cultivated and wealthy merchants of Galle. The few days of his stay there were passed at Queens-House, formerly the official residence of the Governor, now the property of Messrs. Clark, Spence and Co., by whose present head, Mr. Henry Scott, Prof. Haeckel was hospitably entertained, every facility being afforded him for the prosecution of his studies. Among the English residents to whom Prof. Haeckel brought letters, and who vied with each other in making his visit to Galle both profitable and agreeable, he makes special mention of Capt. Blyth and Capt. Bayley. The Villa Marina of the latter gentleman is one of the most charming spots in the neighbourhood of Galle. Built upon a rock jutting far out into the sea, but thickly grown with screw pines, it commands a lovely view of the town and harbour, with a picturesque foreground of rugged black rocks, which serve to enhance the beauty of the fairy-like tropical garden immediately surrounding the Villa.

"Among the many charms of this garden I was particularly interested to find several beautiful examples of the Egyptian Dhum-palm (*Hyphane thebaica*). The stem of this palm does not, like others of the same family, consist of a slender column, but has forked branches, like the Dragon trees, or Dracaenæ; each limb carries a crown of feather-shaded leaves. I had first seen this remarkable palm in the Arabian village of Tur, at the foot of Mount Sinai, and I gave a description of it in my work on 'Arabian Corals.' Great, therefore, was my surprise at finding it here in so altered a dress that I should scarcely have recognised it. The process of adaptation to its altered conditions of existence had completely transformed the tree. The stem was at least twice as large and strong as that of the Egyptian Dhum Palm; the forked branches were more numerous, shorter, and closer together; the huge, feathery leaves were much larger, more luxuriant, and thicker, and the flowers and fruit appeared, as far as my memory served, to have gained in size and beauty.

"In fact every part of the tree had been so modified by the forcing climate of Ceylon that its inherited characteristics seemed in great measure to have disappeared. This magnificent tree had been sown from Egyptian seed, and in twenty years had reached a height of thirty feet. . . .

"Capt. Bayley's charming villa, the Miramare of Galle, is as interesting to the zoologist as to the botanical student. A miniature menagerie constructed in the court-yard contains many curious mammalia and birds, as for example, an ostrich from New Holland, several owls and parrots, and a native ant-eater (*Manis*). This last, together with some curious fish, Capt. Bayley was so kind as to present to me; and later on, at Belligemma, he sent me a Christmas present of a pair of interesting Loris (*Stenops*).

"But more attractive to me than even these curious animals was the splendid coral which covered the surrounding rocks; even the little harbour in which the Captain moored his boat and the stone jetty which formed the landing-place were profusely covered with it, and a few hours sufficed to secure valuable additions to my collection of corals. A large proportion of the animal life inhabiting the extensive coral banks of Galle is here to be found, as it were, epitomised; gigantic black sea-urchins and red star-fish, numerous crabs and fishes, bright-coloured snails and mussels, and curious marine reptiles of many kinds swarmed on the coral branches and crept from between their crevices. No better or more convenient spot could be found for the establishment of a zoological station than Captain Bayley's villa, which, as it so happens, his approaching removal to Colombo renders him willing to dispose of."

Once landed on a coral reef, Prof. Haeckel finds himself at the goal of his desires, and his account of the submarine coral banks which to a great extent block the entrance to the harbour of Galle is too interesting not to be given at length. He regrets at the outset that he could only devote days instead of weeks to their examination. "In this respect, the Viennese artist, Ransonnet, was more fortunate. Possessed of every necessary appliance, including a diving-bell, he was able to devote several weeks to the inspection of the coral banks of Galle, and has given a minute description of them in his illustrated work on Ceylon (Braunschweig, Westermann, 1868). Four coloured plates, for which he made the

---

[1] Continued from page 377.

sketches under water in his diving-bell, give a striking representation of the coral insect "in his habit as he lives." For my own part, it is nine years since, in the spring of 1873 I visited the coral banks of Tur at the foot of Sinai, and there first became acquainted with the wonderful manifestations of life in this submarine fairy land. My interest was roused to the highest pitch, and I endeavoured, in my popular treatise on "Arabian Corals" (Berlin, 1876), briefly to describe the organisation of these curious animals and their mode of life in common with that of various other creatures. The corals of Ceylon as I studied them at Galle, and afterwards in more detail at Belligemma, recalled pleasant memories and enriched my mind with a store of fresh observations."

"The marine fauna of Ceylon is indeed closely related to that of the Arabian shore of the Red Sea, the two having many genera and species in common. But in number and variety of forms of life, the extensive bay of the Indian Ocean with its varied coast formation is far richer than the confined Arabian Gulf where the conditions of life are simpler and more uniform, and I found considerable variations underlying the apparently similar physiognomy of the coral banks in the two districts. Those of Tur were chiefly characterised by warm tones, such as yellow, orange, or red, while the coral groves of Ceylon displayed little but green in every variety of shade. Yellow green Alcyonaria alternated with sea-green Heteropora, malachite green Anthophylla with olive-green Millepora, emerald green Madrapora and Astræa with brown-green Montipora and Mæandrina. Ransonnet has justly remarked on the predominance of green throughout the island of Ceylon. Not only is this 'ever-green isle' decked the whole year through with verdure that never fades, but even the animals that inhabit it are for the most part green in colour. The most frequently occurring birds and lizards, butterflies and beetles, are of a brilliant green hue: so also are many of the fishes and crabs, Amphinomæ and Actinia; even animals which elsewhere are seldom or never green, here don the prevailing livery; such are star-fish (*Ophiuridæ*), sea-urchins, sea-cucumbers, giant-mussels (*Tridacna*), and many others. The explanation of this remarkable phenomenon must be sought for in the Darwinian theory of development, especially in the law of adaptation as applied to the 'sympathetic selection of colour,' which I have demonstrated in my 'Natural History of Creation' (seventh edition, p. 235). The less the colour of an animal differs from that of its surroundings, the less likely it is to attract the attention of its enemies; it is better able also to approach its prey unobserved, and its chances in the struggle for existence are thereby indefinitely increased."

"Natural selection will strengthen the resemblance in colour between animals and their surroundings, as being of advantage to the former. The coral banks of Ceylon, with their inhabitants, afford as good an illustration of this theory as the animals dwelling in the woods and thickets of the island, and in purity and brilliancy of colour the former have a distinct advantage. It would be a great mistake to imagine that an effect of monotony resulted from this tendency to uniformity of colour. On the contrary, the eye is never tired of admiring the manifold combinations and modifications which occur, and which are heightened by the not infrequent juxtaposition of other colours. Just as the brilliant hues, red, yellow, or blue of many of the birds and insects of Ceylon heighten the effect of the dark green foliage, so the coral banks gain in beauty from contrast with the many-coloured marine animals which frequent them. Such are delicately variegated little crabs and fishes which seek their food among the coral branches. Many of the corals themselves are of gay and pleasing colours, *e.g.* rose-red Procilloporæ, red or yellow star coral, violet and brown Heteroporæ, and Madreporæ, &c. Unfortunately, these lovely colours are for the most part very fugitive, and disappear after a short exposure to the air. The cilia and bright tentacula of the sensitive polypi are withdrawn and concealed the instant the coral is disturbed, and the whole becomes dull and colourless."

"The eye which has been charmed by the brilliant hues of the coral grove and its inhabitants is held spell-bound by the beauty and variety of form revealed by these animals. Each individual coral may well be compared to a flower and each group of coral branches to a plant, a tree, or a bush. Indeed, the belief that coral was a vegetable growth was formerly universal, and it was long before the idea of its animal origin gained general acceptance. An entrancing and truly fairy-like view of these marvellous coral banks may be had from a boat during ebb tide, when the sea is calm. In the immediate neighbourhood of the fort of Galle the water is crystal clear, and so shallow that the keel of the boat sometimes grates against the coral, and the outlines of the branches can be distinguished even from the walls of the fort above. A great variety of the most beautiful and remarkable polypi are here comprised within a very small space, and before many days were over I had amassed a large collection."

"Mr. Scott's garden, which he had kindly placed at my disposal for drying purposes, presented a very remarkable appearance during the days of my stay at Queen's House. The lovely tropical plants seemed to be competing for the prize of beauty with the strange marine creatures which had usurped their domain, and the delighted naturalist wandered up and down feasting his eyes now on the one and now on the other, uncertain as to which should carry off the palm. It was impossible not to be struck by the similarity in form between the polypi and many of the garden plants; and the orchids and spice lilies were, in their turn, hardly distinguishable from insects. It was as though the two great kingdoms of the organic world intimated their desire to change places."

"The majority of the coral which I collected in Galle and afterwards in Belligemma was obtained by divers. These I found quite as skilful and enduring as the Arabian divers I had employed nine years before at Tur. Armed with an iron stake they loosened large blocks of coral from their foundation, and raised them with great dexterity into the boat. Many of the blocks weighed from 50 to 80 pounds, and it cost no little trouble and care to deposit them safely. Some of the most beautiful varieties are so brittle, that they break with their own weight when taken out of the water, and cannot by any possibility be preserved entire."

"The full beauty of the coral banks cannot be seen from above, even though the water be so shallow that the points of coral scrape the keel of the boat. Not possessing a diving-bell, I learnt with a little practice to swim to the bottom with my eyes open, and most marvellous were then the effects of the mystic green light in which the submarine world was bathed, so different from the rosy light of the upper air. The forms and movements of the swarms of animals peopling the coral banks were doubly curious and interesting thus seen."

"A multitude of curious fishes, crabs, snails, mussels, star-fish, &c., feed on the coral insect, upon which they make their dwelling, and these coral eaters—which may be classed among parasites—have acquired the most abnormal forms and weapons of defence and aggression, in the course of their adaptation to their peculiar mode of life. But not without risk does the naturalist venture among the coral groves. The Oceanidæ, guardians of the treasures of the deep, warn off the rash intruder in a thousand ways. The fire-coral (*Millepora*) and the Medusæ swimming among them burn, when touched, like the worst of stinging nettles, and the floating stings of many *Synanceia* are as painful and dangerous as those of the scorpion. Then the nip of crabs, large and small, is a peril by no means to be despised. Black sea-urchins

(*Diadema*) bore their long barbed stings into the flesh of the foot, where they break off and remain, inflicting painful and dangerous wounds. But the worst of all injuries to the skin are inflicted by the coral rocks themselves. The myriads of hard points and edges with which they are armed inflict numberless wounds on the hands which attempt to uproot them."

"I never in my life had such a lacerated and smarting skin as after a few days diving and coral fishing at the Point de Galle. The wounds did not heal for several weeks. But what were such temporary sufferings as these in comparison with the wealth of new impressions and delights with which this visit to the wonderful coral-banks of Ceylon enriched my whole future life!"

THE BRITISH ASSOCIATION

THE fifty-second annual meeting of the British Association was opened yesterday at Southampton, when Sir John Lubbock resigned the presidency to Dr. C. W. Siemens, F.R.S., the president-elect. We have already given such full details concerning the arrangements, that at this stage little more remains to be said. All the provisions made by the local committee appear to be quite satisfactory, and although we cannot expect the attendance to be so large as at the Jubilee last year, still some eminent foreign men of science are expected—Helmholtz, Clausius, Du Bois Reymond, J. P. Cook, Langley, Von Rath, Baumhauer, and others.

INAUGURAL ADDRESS BY C. WILLIAM SIEMENS, D.C.L. (OXON), LL.D. (GLASG. AND DUBL.), PH.D., F.R.S., F.C.S., MEMBER INST. C.E., PRESIDENT

IN venturing to address the British Association from this chair, I feel that I have taken upon myself a task involving very serious responsibility. The Association has for half a century fulfilled the important mission of drawing together, once every year, scientists from all parts of the country for the purpose of discussing questions of mutual interest, and of cultivating those personal relations which aid so powerfully in harmonising views, and in stimulating concerted action for the advancement of science.

A sad event casts a shadow over our gathering. While still mourning the irreparable loss Science had sustained in the person of Charles Darwin, whose bold conceptions, patient labour, and genial mind made him almost a type of unsurpassed excellence, telegraphic news reached Cambridge just a month ago, to the effect that our Honorary Secretary, Professor F. M. Balfour, had lost his life during an attempted ascent of the Aiguille Blanche de Penteret. Although only thirty years of age, few men have won distinction so rapidly and so deservedly. After attending the lectures of Michael Foster, he completed his studies of Biology under Dr, Anton Dohrn at the Zoological Station of Naples in 1875. In 1878 he was elected a Fellow, and in November last a member of the Council of the Royal Society, when he was also awarded one of the Royal Medals for his embryological researches. Within a short interval of time Glasgow University conferred on him their honorary degree of LL.D., he was elected President of the Cambridge Philosophical Society, and after having declined very tempting offers from the Universities of Oxford and Edinburgh he accepted a professorship of Animal Morphology created for him by his own University. Few men could have borne without hurt such a stream of honourable distinctions, but in young Balfour genius and independence of thought were happily blended with industry and personal modesty; these won for him the friendship, esteem, and admiration of all who knew him.

Since the days of the first meeting of the Association in York in 1831, great changes have taken place in the means at our disposal for exchanging views, either personally or through the medium of type. The creation of the railway system has enabled congenial minds to attend frequent meetings of those special Societies, which have sprung into existence since the foundation of the British Association, amongst which I need only name here the Physical, Geographical, Meteorological, Anthropological, and Linnean, cultivating abstract science, and the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Society of Telegraph Engineers and Electricians, the Gas Institute, the Sanitary Institute, and the Society of Chemical Industry, representing applied science. These meet at frequent intervals in London, whilst others, having similar objects in view, hold their meetings at the University towns, and at other centres of intelligence and industry throughout the country, giving evidence of great mental activity, and producing some of those very results which the founders of the British Association wished to see realised. If we consider further the extraordinary development of scientific journalism which has taken place, it cannot surprise us when we meet with expressions of opinion to the effect that the British Association has fulfilled its mission, and should now yield its place to those special Societies it has served to call into existence. On the other hand, it may be urged that the brilliant success of last year's Anniversary Meeting, enhanced by the comprehensive address delivered on that occasion by my distinguished predecessor in office, Sir John Lubbock, has proved, at least, that the British Association is not dead in the affection of its members, and it behoves us at this, the first ordinary gathering in the second half century, to consider what are the strong points to rely upon for the continuance of a career of success and usefulness.

If the facilities brought home to our doors of acquiring scientific information have increased, the necessities for scientific inquiry have increased in a greater ratio. The time was when science was cultivated only by the few, who looked upon its application to the arts and manufactures as almost beneath their consideration; this they were content to leave in the hands of others, who, with only commercial aims in view, did not aspire to further the objects of science for its own sake, but thought only of benefiting by its teachings. Progress could not be rapid under this condition of things, because the man of pure science rarely pursued his inquiry beyond the mere enunciation of a physical or chemical principle, whilst the simpler practitioner was at a loss how to harmonise the new knowledge with the stock of information which formed his mental capital in trade.

The advancement of the last fifty years has, I venture to submit, rendered theory and practice so interdependent, that an intimate union between them is a matter of absolute necessity for our future progress. Take, for instance, the art of dyeing, and we find that the discovery of new colouring matters derived from waste products, such as coal-tar, completely changes its practice, and renders an intimate knowledge of the science of chemistry a matter of absolute necessity to the practitioner. In telegraphy and in the new arts of applying electricity to lighting, to the transmission of power, and to metallurgical operations, problems arise at every turn, requiring for their solution not only an intimate acquaintance with, but a positive advance upon electrical science, as established by purely theoretical research in the laboratory. In general engineering the mere practical art of constructing a machine so designed and proportioned as to produce mechanically the desired effect, would suffice no longer. Our increased knowledge of the nature of the mutual relations between the different forms of energy makes us see clearly what are the theoretical limits of effect; these, although beyond our absolute reach, may be looked upon as the asymptotes to be approached indefinitely by the hyperbolic course of practical progress, of which we should never lose sight. Cases arise, moreover, where the introduction of new materials of construction, or the call for new effects, renders former rules wholly insufficient. In all these cases practical knowledge has to go hand in hand with advanced science in order to accomplish the desired end.

Far be it from me to think lightly of the ardent students of nature who, in their devotion to research, do not allow their minds to travel into the regions of utilitarianism and of self-interest. These, the high priests of science, command our utmost admiration; but it is not to them that we can look for our current progress in practical science, much less can we look for it to the "rule of thumb" practitioner, who is guided by what comes nearer to instinct than to reason. It is to the man of science, who also gives attention to practical questions, and to the practitioner, who devotes part of his time to the prosecution of strictly scientific investigations, that we owe the rapid progress of the present day, both merging more and more into one class, that of pioneers in the domain of nature. It is such men that Archimedes must have desired when he refused to teach his disciples the art of constructing his powerful ballistic engines, exhorting them to give their attention to the principles involved in their construction, and that Telford, the founder of the Institution of Civil Engineers, must have had in his mind's eye, when he defined civil engineering as "the art of directing the great sources of power in nature."

These considerations may serve to show that although we see the men of both abstract and applied science group themselves in minor bodies for the better prosecution of special objects, the points of contact between the different branches of knowledge are ever multiplying, all tending to form part of a mighty tree—the tree of modern science—under whose ample shadow its cultivators will find it both profitable and pleasant to meet, at least once a year; and considering that this tree is not the growth of one country only, but spreads both its roots and branches far and wide, it appears desirable that at these yearly gatherings other nations should be more fully represented than has hitherto been the case. The subjects discussed at our meetings are without exception of general interest, but many of them bear an international character, such as the systematic collection of magnetic, astronomical, meteorological, and geodetical observations, the formation of a universal code for signalling at sea, and for distinguishing lighthouses, and especially the settlement of scientific nomenclatures and units of measurement, regarding all of which an international accord is a matter of the utmost practical importance.

As regards the measures of length and weight it is to be regretted that this country still stands aloof from the movement initiated in France towards the close of last century; but, considering that in scientific work metrical measure is now almost universally adopted, and that its use has been already legalised in this country, I venture to hope that its universal adoption for commercial purposes will soon follow as a matter of course. The practical advantages of such a measure to the trade of this country would, I am convinced, be very great, for English goods, such as machinery or metal rolled to current sections, are now almost excluded from the continental market, owing to the unit measure employed in their production. The principal impediment to the adoption of the metre consists in the strange anomaly that although it is legal to use that measure in commerce, and although a copy of the standard metre is kept in the Standards' Department of the Board of Trade, it is impossible to procure legalised rods representing it, and to use a non-legalised copy of a standard in commerce is deemed fraudulent. Would it not be desirable that the British Association should endeavour to bring about the use in this country of the metre and kilogramme, and, as a preliminary step, petition the Government to be represented on the International Metrical Commission, whose admirable establishment at Sèvres possesses, independently of its practical work, considerable scientific interest, as a well-found laboratory for developing methods of precise measurement.

Next in importance to accurate measures of length, weight, and time, stand, for the purposes of modern science, those of electricity.

The remarkably clear lines separating conductors from non-conductors of electricity, and magnetic from non-magnetic substances, enable us to measure electrical quantities and effects with almost mathematical precision; and, although the ultimate nature of this, the youngest scientifically investigated form of energy, is yet wrapt in mystery, its laws are the most clearly established, and its measuring instruments (galvanometers, electrometers, and magnetometers), are amongst the most accurate in physical science. Nor could any branch of science or industry be named in which electrical phenomena do not occur, to exercise their direct and important influence.

If, then, electricity stands foremost amongst the exact sciences, it follows that its unit measures should be determined with the utmost accuracy. Yet, twenty years ago very little advance had been made towards the adoption of a rational system. Ohm had, it is true, given us the fixed relations existing between electromotive force, resistance, and quantity of current; Joule had established the dynamical equivalent of heat and electricity, and Gauss and Weber had proposed their elaborate system of absolute magnetic measurement. But these invaluable researches appeared only as isolated efforts, when, in 1862, the Electric Unit Committee was appointed by the British Association, at the instance of Sir William Thomson, and it is to the long-continued activity of this Committee that the world is indebted for a consistent and practical system of measurement, which, after being modified in details, received universal sanction last year by the International Electrical Congress assembled at Paris.

At this Congress, which was attended officially by the leading physicists of all civilised countries, the attempt was successfully made to bring about a union between the statical system of measurement that had been followed in Germany and some other countries, and the magnetic or dynamical system developed by the British Association, also between the geometrical measure of resistance, the (Werner) Siemens unit, that had been generally adopted abroad, and the British Association unit intended as a multiple of Weber's absolute unit, though not entirely fulfilling that condition. The Congress, while adopting the absolute system of the British Association, referred the final determination of the unit measure of resistance to an International Committee, to be appointed by the representatives of the several Governments; they decided to retain the mercury standard for reproduction and comparison, by which means the advantages of both systems are happily combined, and much valuable labour is utilised; only, instead of expressing electrical quantities directly in absolute measure, the Congress has embodied a consistent system, based on the Ohm, in which the units are of a value convenient for practical measurements. In this, which we must hereafter know as the "practical system," as distinguished from the "absolute system," the units are named after leading physicists, the Ohm, Ampère, Volt, Coulomb, and Farad.

I would venture to suggest that two further units might, with advantage, be added to the system decided on by the International Congress at Paris. The first of these is the unit of magnetic quantity or pole. It is of much importance, and few will regard otherwise than with satisfaction the suggestion of Clausius that the unit should be called a "Weber," thus retaining a name most closely connected with electrical measurements, and only omitted by the Congress in order to avoid the risk of confusion in the magnitude of the unit current with which his name had been formerly associated.

The other unit I should suggest adding to the list is that of power. The power conveyed by a current of an Ampère through the difference of potential of a Volt is the unit consistent with the practical system. It might be appropriately called a Watt, in honour of that master mind in mechanical science, James Watt. He it was who first had a clear physical conception of power, and gave a rational method of measuring it. A Watt, then, expresses the rate of an Ampère multiplied by a Volt, whilst a horse-power is 746 Watts, and a Cheval de Vapeur 735.

The system of electro-magnetic units would then be :—

(1) Weber, the unit of magnetic quantity $=10^8$ C.G.S. Units.
(2) Ohm ,, ,, resistance $=10^9$,,
(3) Volt ,, ,, electromotive force $=10^8$,,
(4) Ampère ,, ,, current $=10^{-1}$,,
(5) Coulomb ,, ,, quantity $=10^{-1}$,,
(6) Watt ,, ,, power $=10^7$,,
(7) Farad ,, ,, capacity $=10^{-9}$,.

Before the list can be looked upon as complete two other units may have to be added, the one expressing that of magnetic field, and the other of heat in terms of the electro-magnetic system. Sir William Thomson suggested the former at the Paris Congress, and pointed out that it would be proper to attach to it the name of Gauss, who first theoretically and practically reduced observations of terrestrial magnetism to absolute measure. A Gauss will, then, be defined as the intensity of field produced by a Weber at a distance of one centimetre; and the Weber will be the absolute C.G.S. unit strength of magnetic pole. Thus the mutual force between two ideal point poles, each of one Weber strength held at unit distance asunder, will be one dyne; that is to say, the force which, acting for a second of time on a gramme of matter, generates a velocity of one centimetre per second.

The unit of heat has hitherto been taken variously as the heat required to raise a pound of water at the freezing-point through 1° Fahrenheit or Centigrade, or, again, the heat necessary to raise a kilogramme of water 1° Centigrade. The inconvenience of a unit so entirely arbitrary is sufficiently apparent to justify the introduction of one based on the electro-magnetic system, viz., the heat generated in one second by the current of an Ampère flowing through the resistance of an Ohm. In absolute measure its value is 10^7 C.G.S. units, and, assuming Joule's equivalent as 42,000,000, it is the heat necessary to raise 0·238 grammes of water 1° Centigrade, or, approximately, the $\frac{1}{1000}$th part of the arbitrary unit of a pound of water raised 1° Fahrenheit and the $\frac{1}{4000}$th of the kilogramme of water raised 1° Centigrade. Such a heat unit, if found acceptable, might with great propriety, I think, be called the Joule, after the man who has done so much to develop the dynamical theory of heat.

Professor Clausius urges the advantages of the statical system of measurement for simplicity, and shows that the numerical values of the two systems can readily be compared by the introduction of a factor, which he proposes to call the critical velocity; this, Weber has already shown to be nearly the same as the velocity of light. It is not immediately evident how by the introduction of a simple multiple, signifying a velocity, the statical can be changed into dynamical values, and I am indebted to my friend Sir William Thomson for an illustration which struck me as remarkably happy and convincing. Imagine a ball of conducting matter so constituted that it can at pleasure be caused to shrink. Now let it first be electrified and left insulated with any quantity of electricity on it. After that, let it be connected with the earth by an excessively fine wire or a not perfectly dry silk fibre; and let it shrink just so rapidly as to keep its potential constant, till the whole charge is carried off. The velocity with which its surface approaches its centre is the electrostatic measure of the conducting power of the fibre. Thus we see how "conducting power" is, in electrostatic theory, properly measured in terms of a velocity. Weber had shown how, in electromagnetic theory, the resistance, or the reciprocal of the conducting power of a conductor, is properly measured by a velocity. The critical velocity, which measures the conducting power in electrostatic reckoning and the resistance in electromagnetic, of one and the same conductor, measures the number of electrostatic units in the electromagnetic unit of electric quantity.

Without waiting for the assembling of the International Committee charged with the final determination of the Ohm, one of its most distinguished members, Lord Rayleigh, has, with his collaborateuse, Mrs. Sidgwick, continued his important investigation in this direction at the Cavendish Laboratory, and has lately placed before the Royal Society a result which will probably not be surpassed in accuracy. His redetermination brings him into close accord with Dr. Werner Siemens, their two values of the mercury unit being 0·95418 and 0·9536 of the B.A. unit respectively, or 1 mercury unit$=0{\cdot}9413 \times 10^9$ C.G.S. units.

Shortly after the publication of Lord Rayleigh's recent results, Messrs. Glazebrook, Dodds, and Sargant, of Cambridge, communicated to the Royal Society two determinations of the Ohm, by different methods; and it is satisfactory to find that their final values differ only in the fourth decimal, the figures being, according to

Lord Rayleigh . . . $1\ \text{Ohm}=0{\cdot}98651\ \dfrac{\text{Earth Quadrant}}{\text{Second}}$

Messrs. Glazebrook, etc. $=0{\cdot}986439$,,

Professor E. Wiedemann, of Leipzig, has lately called attention to the importance of having the Ohm determined in the most accurate manner possible, and enumerates four distinct methods, all of which should unquestionably be tried with a view of obtaining concordant results, because upon its accuracy will depend the whole future system of measurement of energy of whatever form.

The word Energy was first used by Young in a scientific sense, and represents a conception of recent date, being the outcome of the labours of Carnot, Mayer, Joule, Grove, Clausius, Clerk-Maxwell, Thomson, Stokes, Helmholtz, Macquorn-Rankine, and other labourers, who have accomplished for the science regarding the forces in Nature what we owe to Lavoisier, Dalton, Berzelius, Liebig, and others, as regards Chemistry. In this short word Energy we find all the efforts in nature, including electricity, heat, light, chemical action, and dynamics, equally represented, forming, to use Dr. Tyndall's apt expression, so many "modes of motion." It will readily be conceived that when we have established a fixed numerical relation between these different modes of motion, we know beforehand what is the utmost result we can possibly attain in converting one form of energy into another, and to what extent our apparatus for effecting the conversion falls short of realising it. The difference between ultimate theoretical effect and that actually obtained is commonly called loss, but, considering that energy is indestructible, represents really secondary effect which we obtain without desiring it. Thus friction in the working parts of a machine represents a loss of mechanical effect, but is a gain of heat, and in like manner the loss sustained in transferring electrical energy from one point to another is accounted for by heat generated in the conductor. It sometimes suits our purpose to augment the transformation of electrical into heat energy at certain points of the circuit when the heat rays become visible, and we have the incandescence electric light. In effecting a complete severance of the conductor for a short distance, after the current has been established, a very great local resistance is occasioned, giving rise to the electric arc, the highest development of heat ever attained. Vibration is another form of lost energy in mechanism, but who would call it a loss if it proceeded from the violin of a Joachim or a Norman-Neruda?

Electricity is the form of energy best suited for transmitting an effect from one place to another; the electric current passes through certain substances—the metals—with a velocity limited only by the retarding influence caused by electric charge of the surrounding dielectric, but approaching probably under favourable conditions that of radiant heat and light, or 300,000 kilometres per second; it refuses, however, to pass through oxidised substances, glass, gums, or through gases except when in a highly rarefied condition. It is easy therefore to confine the electric current within bounds, and to direct it through narrow channels of extraordinary length. The conducting wire of an Atlantic cable is such a narrow channel; it consists of a copper wire, or strand of wires, 5 mm. in diameter, by nearly 5,000 kilometres in length, confined electrically by a coating of gutta-percha about 4 mm. in thickness. The electricity from a small galvanic battery passing into this channel prefers the long journey to America in the good conductor, and back through the earth, to the shorter journey across the 4 mm. in thickness of insulating material. By an improved arrangement the alternating currents employed to work long submarine cables do not actually complete the circuit, but are merged in a condenser at the receiving station after having produced their extremely slight but certain effect upon the receiving instrument, the beautiful syphon recorder of Sir William Thomson. So perfect is the channel and so precise the action of both the transmitting and receiving instruments employed, that two systems of electric signals may be passed simultaneously through the same cable in opposite directions, producing independent records at either end. By the application of this duplex mode of working to the Direct United States cable under the superintendence of Dr. Muirhead, its transmitting power was increased from twenty-five to sixty words a minute, being equivalent to about twelve currents or primary impulses per second. In transmitting these impulse-currents simultaneously from both ends of the line, it must not be imagined, however, that they pass each other in the manner of liquid waves belonging to separate systems; such a supposition would involve momentum in the electric flow, and although the effect produced is analogous to such an action, it rests upon totally different grounds—namely, that of a local circuit at each terminus being called into action automatically whenever two similar currents are passed into the line simultaneously from both ends. In extending this principle of action quadruplex telegraphy has been rendered possible, although not yet for long submarine lines.

The minute currents here employed are far surpassed as regards delicacy and frequency by those revealed to us by that marvel of the present day, the telephone. The electric currents caused by the vibrations of a diaphragm acted upon by the human voice, naturally vary in frequency and intensity according to the number and degree of those vibrations, and each motor current in exciting the electro-magnet forming part of the receiving instrument, deflects the iron diaphragm occupying the position of an armature to a greater or smaller extent according to its strength. Savart found that the fundamental *la* springs from 440 complete vibrations in a second, but what must be the frequency and modulations of the motor current and of magnetic variations necessary to convey to the ear through the medium of a vibrating armature, such a complex of human voices and of musical instruments as constitutes an opera performance. And yet such performances could be distinctly heard and even enjoyed as an artistic treat by applying to the ears a pair of the double telephonic receivers at the Paris Electrical Exhibition, when connected with a pair of transmitting instruments in front of the footlights of the Grand Opera. In connection with the telephone, and with its equally remarkable adjunct the microphone, the names of Riess, Graham Bell, Edison, and Hughes, will ever be remembered.

Considering the extreme delicacy of the currents working a telephone, it is obvious that those caused by induction from neighbouring telegraphic line wires would seriously interfere with the former, and mar the speech or other sounds produced through their action. To avoid such interference the telephone wires if suspended in the air require to be placed at some distance from telegraphic line wires, and to be supported by separate posts. Another way of neutralising interference consists in twisting two separately insulated telephone wires together, so as to form a strand, and in using the two conductors as a metallic circuit to the exclusion of the earth; the working current will, in that case, receive equal and opposite inductive influences, and will therefore remain unaffected by them. On the other hand two insulated wires instead of one are required for working one set of instruments; and a serious increase in the cost of installation is thus caused. To avoid this Mr. Jacob has lately suggested a plan of combining pairs of such metallic circuits again into separate working pairs, and these again with other working pairs, whereby the total number of telephones capable of being worked without interference is made to equal the total number of single wires employed. The working of telephones and telegraphs in metallic circuit has the further advantage that mutual volta induction between the outgoing and returning currents favours the transit, and neutralises on the other hand the retarding influence caused by charge in underground or submarine conductors. These conditions are particularly favourable to underground line wires, which possess other important advantages over the still prevailing overground system, in that they are unaffected by atmospheric electricity, or by snow-storms and heavy gales, which at not very rare intervals of time put us back to pre-telegraphic days, when the letter-carrier was our swiftest messenger.

The underground system of telegraphs, first introduced into Germany by Werner Siemens in the years 1847-8, had to yield for a time to the overground system owing to technical difficulties, but it has been again resorted to within the last four years, and multiple land cables of solid construction now connect all the important towns of that country. The first cost of such a system is no doubt considerable (being about 38*l.* per kilometre of conductor as against 8*l.* 10*s.* the cost of land lines); but as the underground wires are exempt from frequent repairs and renewals, and as they insure continuity of service, they are decidedly the cheaper and better in the end. The experience afforded by the early introduction of the underground system in Germany, was not, however, without its beneficial results, as it brought to light the phenomena of lateral induction, and of faults in the insulating coating, matters which had to be understood before submarine telegraphy could be attempted with any reasonable prospect of success.

Regarding the transmission of power to a distance the electric current has now entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope as used at Schaffhausen to utilise the power of the Rhine fall. The transformation of electrical into mechanical energy, can be accomplished with no further loss than is due to such incidental causes as friction and the heating of wires; these in a properly designed dynamo-electric machine do not exceed 10 per cent., as shown by Dr. John Hopkinson, and, judging from recent experiments of my own, a still nearer approach to ultimate perfection is attainable. Adhering, however, to Dr. Hopkinson's determination for safety's sake, and assuming the same percentage in reconverting the current into mechanical effect, a total loss of 19 per cent. results. To this loss must be added that through electrical resistance in the connecting line wires, which depends upon their length and conductivity, and that due to heating by friction of the working parts of the machine. Taking these as being equal to the internal losses incurred in the double process of conversion, there remains a useful effect of 100 — 38 = 62 per cent., attainable at a distance, which agrees with experimental results, although in actual practice it would not be safe at present to expect more than 50 per cent. of ultimate useful effect, to allow for all mechanical losses.

In using compressed air or water for the transmission of power the loss cannot be taken at less than 50 per cent., and as it depends upon fluid resistance it increases with distance more rapidly than in the case of electricity. Taking the loss of effect in all cases as 50 per cent., electric transmission presents the advantage that an insulated wire does the work of a pipe capable of withstanding high internal pressure, which latter must be more costly to put down and to maintain. A second metallic conductor is required, however, to complete the electrical circuit, as the conducting power of the earth alone is found unreliable for passing quantity currents, owing to the effects of polarization; but as this second conductor need not be insulated, water or gas pipes, railway metals or fencing wire, may be called into requisition for the purpose. The small space occupied by the electro-motor, its high working speed, and the absence of waste products, render it specially available for the general distribution of power to cranes and light machinery of every description. A loss of effect of 50 per cent. does not stand in the way of such applications, for it must be remembered that a powerful central engine of best construction produces motive power with a consumption of two pounds of coal per horse-power per hour, whereas small engines distributed over a district would consume not less than five; we thus see that there is an advantage in favour of electric transmission as regards fuel, independently of the saving of labour and other collateral benefits.

To agriculture, electric transmission of power seems well adapted for effecting the various operations of the farm and fields from one centre. Having worked such a system myself in combination with electric lighting and horticulture for upwards of two years, I can speak with confidence of its economy, and of the facility with which the work is accomplished in charge of untrained persons.

As regards the effect of the electric light upon vegetation there is little to add to what was stated in my paper read before Section A last year, and ordered to be printed with the Report, except that in experimenting upon wheat, barley, oats, and other cereals sown in the open air, there was a marked difference between the growth of the plants influenced and those uninfluenced by the electric light. This was not very apparent till towards the end of February, when, with the first appearance of mild weather, the plants under the influence of an electric lamp of 4,000 candle power placed about 5 metres above the surface, developed with extreme rapidity, so that by the end of May they stood 4 feet high, with the ears in full bloom, when those not under its influence were under 2 feet in height, and showed no sign of the ear.

In the electric railway first constructed by Dr. Werner Siemens, at Berlin, in 1879, electric energy was transmitted to the moving carriage or train of carriages through the two rails upon which it moved, these being sufficiently insulated from each other by being placed upon well creosoted cross sleepers. At the Paris Electrical Exhibition the current was conveyed through two separate conductors making sliding or rolling contact with the carriage, whereas in the electric railway now in course of construction in the north of Ireland (which when completed will have a length of twelve miles) a separate conductor will be provided by the side of the railway, and the return circuit completed through the rails themselves, which in that case need not be insulated; secondary batteries will be used to store the surplus energy created in running downhill, to be restored in ascending steep inclines, and for passing roadways where the separate insulated conductor is not practicable. The electric railway possesses great advantages over horse or steam-power for towns, in tunnels, and in all cases where natural sources of energy, such as waterfalls are available; but it would not be reasonable to suppose that it will in its present condition compete with steam propulsion upon ordinary railways. The transmission of power by means of electric conductors possesses the further advantage over other means of transmission that, provided the resistance of the rails be not very great, the power communicated to the locomotive reaches its maximum when the motion is at its minimum—that is, in commencing to work, or when encountering an exceptional resistance — whereas the utmost economy is produced in the normal condition of working when the velocity of the power-absorbing nearly equals that of the current-producing machine.

The deposition of metals from their solutions is perhaps the oldest of all useful applications of the electric current, but it is only in very recent times that the dynamo current has been practically applied to the refining of copper and other metals, as now practised at Birmingham and elsewhere, and upon an exceptionally large scale at Ocker, in Germany. The dynamo machine there employed was exhibited at the Paris Electrical Exhibition by Dr. Werner Siemens, its peculiar feature being that the conductors upon the rotating armature consisted of solid bars of copper 30 mm. square, in section, which were found only just sufficient to transmit the large quantity of electricity of low tension necessary for this operation. One such machine consuming 4-horse power deposits about 300 kilogrammes of copper per 24 hours; the motive power at Ocker is derived from a waterfall.

Electric energy may also be employed for heating purposes, but in this case it would obviously be impossible for it to compete in point of economy with the direct combustion of fuel for the attainment of ordinary degrees of heat. Bunsen and St. Claire Deville have taught us, however, that combustion becomes extremely sluggish when a temperature of 1,800° C. has been reached, and for effects at temperatures exceeding that limit the electric furnace will probably find advantageous applications. Its specific advantage consists in being apparently unlimited in the degree of heat attainable, thus opening out a new field of investigation to the chemist and metallurgist. Tungsten has been melted in such a furnace, and 8 pounds of platinum have been reduced from the cold to the liquid condition in 20 minutes.

The largest and most extensive application of electric energy at the present time is to lighting, but, considering how much of late has been said and written for and against this new illuminant, I shall here confine myself to a few general remarks. Joule has shown that if an electric current is passed through a conductor, the whole of the energy lost by the current is converted into heat; or, if the resistance be localised, into radiant energy comprising heat, light, and actinic rays. Neither the low heat rays nor the ultra-violet of highest refrangibility affect the retina, and may be regarded as lost energy, the effective rays being those between the red and violet of the spectrum, which in their combination produce the effect of white light.

Regarding the proportion of luminous to non-luminous rays proceeding from an electric arc or incandescent wire, we have a most valuable investigation by Dr. Tyndall, recorded in his work on "Radiant Heat." Dr. Tyndall shows that the luminous rays from a platinum wire heated to its highest point of incandescence, which may be taken at 1,700° C., formed $\frac{1}{24}$th part of the total radiant energy emitted, and $\frac{1}{10}$th part in the case of an arc light worked by a battery of 50 Grove's elements. In order to apply these valuable data to the case of electric lighting by means of dynamo-currents, it is necessary in the first place to determine what is the power of 50 Grove's elements of the size used by Dr. Tyndall, expressed in the practical scale of units as now established. From a few experiments lately undertaken for myself, it would appear that 50 such cells have an electro-motive force of 98·5 Volts, and an internal resistance of 13·5 Ohms, giving a current of 7·3 Ampères when the cells are short-circuited. The resistance of a regulator such as Dr. Tyndall used in his experiments may be taken at 10 Ohms, the current produced in the arc would be $\frac{98\cdot5}{13\cdot5 + 10 + 1} = 4$ Ampères (allowing one Ohm for the leads), and the power consumed $10 \times 4^2 = 160$ Watts; the light power of such an arc would be about 150 candles, and, comparing this with an arc of 3,308 candles produced by 1,162 Watts, we find that $\left(\frac{1162}{160}\right)$, *i.e.*, 7·3 times the electric energy produce $\left(\frac{3308}{150}\right)$, *i.e.*, 22 times the amount of light measured horizontally. If therefore, in Dr. Tyndall's arc $\frac{1}{10}$th of the radiant energy emitted was visible as light, it follows that in a powerful arc of 3,300 candles, $\frac{1}{10} \times \frac{22\cdot0}{7\cdot3}$, or fully $\frac{1}{3}$, are luminous rays. In the case of the incandescence light (say a Swan light of 20 candle power) we find in practice that nine times as much power has to be expended as in the case of the arc light; hence $\frac{1}{3} \times \frac{1}{9} = \frac{1}{27}$ part of the power is given out as luminous rays, as against $\frac{1}{24}$th in Dr. Tyndall's incandescent platinum—a result sufficiently approximate considering the wide difference of conditions under which the two are compared.

These results are not only of obvious practical value, but they seem to establish a fixed relation between current, temperature, and light produced, which may serve as a means to determine temperatures exceeding the melting point of platinum with greater accuracy than has hitherto been possible by actinimetric methods in which the thickness of the luminous atmosphere must necessarily exercise a disturbing influence. It is probably owing to this circumstance that the temperature of the electric arc as well as that of the solar photosphere has frequently been greatly over-estimated.

The principal argument in favour of the electric light is furnished by its immunity from products of combustion which not only heat the lighted apartments, but substitute carbonic acid and deleterious sulphur compounds for the oxygen upon which respiration depends; the electric light is white instead of yellow, and thus enables us to see pictures, furniture, and flowers as by daylight; it supports growing plants instead of poisoning them, and by its means we can carry on photography and many other industries at night as well as during the day. The objection frequently urged against the electric light, that it depends upon the continuous motion of steam or gas engines, which are liable to accidental stoppage, has been removed by the introduction into practical use of the secondary battery; this, although not embodying a new conception, has lately been greatly improved in power and constancy by Planté, Faure, Volckmar, Sellon, and others, and promises to accomplish for electricity what the gas-holder has done for the supply of gas, and the accumulator for hydraulic transmission of power.

It can no longer be a matter of reasonable doubt, therefore, that electric lighting will take its place as a public illuminant, and that even though its cost should be found greater than that of gas, it will be preferred for the lighting of drawing-rooms and dining-rooms, theatres and concert-rooms, museums, churches, warehouses, show-rooms, printing establishments and factories, and also the cabins and engine-rooms of passenger steamers. In the cheaper and more powerful form of the arc light, it has proved itself superior to any other illuminant for spreading artificial daylight over the large areas of harbours, railway-stations, and the sites of public works. When placed within a holophote the electric lamp has already become a powerful auxiliary in effecting military operations both by sea and land.

The electric light may be worked by natural sources of power such as waterfalls, the tidal wave, or the wind, and it is conceivable that these may be utilised at considerable distances by means of metallic conductors. Some five years ago I called attention to the vastness of those sources of energy, and the facility offered by electrical conduction in rendering them available for lighting and power supply, while Sir William Thomson made this important matter the subject of his admirable address to section A last year at York, and dealt with it in an exhaustive manner.

The advantages of the electric light and of the distribution of power by electricity have lately been recognised by the British Government, who have just passed a Bill through Parliament to facilitate the establishment of electrical conductors in towns, subject to certain regulating clauses to protect the interests of the public and of local authorities. Assuming the cost of electric light to be practically the same as gas, the preference for one or other will in each application be decided upon grounds of relative convenience, but I venture to think that gas-lighting will hold its own as the poor man's friend.

Gas is an institution of the utmost value to the artisan; it requires hardly any attention, is supplied upon regulated terms, and gives with what should be a cheerful light a genial warmth, which often saves the lighting of a fire. The time is moreover not far distant, I venture to think, when both rich and poor will largely resort to gas as the most convenient, the cleanest, and the cheapest of heating agents, and when raw coal will be seen only at the colliery or the gasworks. In all cases where the town to be supplied is within say thirty miles of the colliery, the gasworks may with advantage be planted at the mouth, or still better at the bottom of the pit, whereby all haulage of fuel would be avoided, and the gas, in its ascent from the bottom of the colliery, would acquire an onward pressure sufficient probably to impel it to its destination. The possibility of transporting combustible gas through pipes for such a distance has been proved at Pittsburg, where natural gas from the oil district is used in large quantities.

The quasi monopoly so long enjoyed by gas companies has had the inevitable effect of checking progress. The gas being supplied by meter, it has been seemingly to the advantage of the companies to give merely the prescribed illuminating power, and to discourage the invention of economical burners, in order that the consumption might reach a maximum. The application of gas for heating purposes has not been encouraged, and is still made difficult in consequence of the objectionable practice of reducing the pressure in the mains during daytime to the lowest possible point consistent with prevention of atmospheric indraught. The introduction of the electric light has convinced gas managers and directors that such a policy is no longer tenable, but must give way to one of technical progress; new processes for cheapening the production and increasing the purity and illuminating power of gas are being fully discussed before the Gas Institute; and improved burners, rivalling the electric light in brilliancy, greet our eyes as we pass along our principal thoroughfares.

Regarding the importance of the gas supply as it exists at present, we find from a Government return that the capital invested in gasworks in England, other than those of local authorities, amounts to 30,000,000*l.*; in these 4,281,048 tons of coal are converted annually, producing 43,000 million cubic feet of gas, and about 2,800,000 tons of coke; whereas the total amount of coal annually converted in the United Kingdom may be estimated at 9,000,000 tons, and the by-products therefrom at 500,000 tons of tar, 1,000,000 tons of ammonia liquor, and 4,000,000 tons of coke, according to the returns kindly furnished me by the managers of many of the gasworks and corporations. To these may be added say 120,000 tons of sulphur, which up to the present time is a waste product.

Previous to the year 1856—that is to say, before Mr. W. H. Perkin had invented his practical process, based chiefly upon the theoretical investigations of Hoffman, regarding the coal-tar bases and the chemical constitution of indigo—the value of coal-tar in London was scarcely a halfpenny a gallon, and in country places gas-makers were glad to give it away. Up to that time the coal-tar industry had consisted chiefly in separating the tar by distillation into naphtha, creosote, oils, and pitch. A few distillers, however, made small quantities of benzene, which had been first shown—by Mansfield, in 1849—to exist in coal-tar naphtha mixed with toluene, cumene, &c. The discovery, in 1856, of the mauve or aniline purple gave a great impetus to the coal-tar trade, inasmuch as it necessitated the separation of large quantities of benzene, or a mixture of benzene and toluene, from the naphtha. The trade was further increased by the discovery of the magenta or rosaniline dye, which required the same products for its preparation. In the meantime, carbolic acid was gradually introduced into commerce, chiefly as a disinfectant, but also for the production of colouring matter.

The next most important development arose from the discovery by Græbe and Liebermann that alizarine, the colouring principle of the madder root, was allied to anthracene, a hydrocarbon existing in coal-tar. The production of this colouring matter from anthracene followed, and is now one of the most important operations connected with tar distilling. The success of the alizarine made in this manner has been so great that it has almost entirely superseded the use of madder, which is now cultivated to only a comparatively small extent. The most important colouring matters recently introduced are the azo-scarlets. They have called into use the coal-tar hydrocarbons, xylene and cumene. Naphthalene is also used in their preparation. These splendid dyes have replaced cochineal in many of its applications, and have thus seriously interfered with its use. The discovery of artificial indigo by Professor Baeyer is of great interest. For the preparation of this colouring matter toluene is required. At present artificial indigo does not compete seriously with the natural product; but should it eventually be prepared in quantity from toluene, a further stimulus will be given to the coal-tar trade.

The colour industry utilises even now practically all the benzene, a large proportion of the solvent naptha, all the anthracene, and a portion of the napthaline resulting from the distillation of coal-tar; and the value of the colouring matter thus produced is estimated by Mr. Perkin at 3,350,000*l.*

The demand for ammonia may be taken as unlimited, on account of its high agricultural value as a manure; and, considering the failing supply of guano and the growing necessity for stimulating the fertility of our soil, an increased production of ammonia may be regarded as a matter of national importance, for the supply of which we have to look almost exclusively to our gasworks. The present production of 1,000,000 tons of liquor yields 95,000 tons of sulphate of ammonia; which, taken at 20*l.* 10*s.* a ton, represents an annual value of 1,947,000*l.*

The total annual value of the gasworks by-products may be estimated as follows:—

Colouring matter	£3,350,000
Sulphate of ammonia	1,947,000
Pitch (325,000 tons)	365,000
Creosote (25,000,000 gallons) . . .	208,000
Crude carbolic acid (1,000,000 gallons). .	100,000
Gas coke, 4,000,000 tons (after allowing 2,000,000 tons consumption in working the retorts) at 12*s.*	2,400,000
Total	£8,370,000

Taking the coal used, 9,000,000 tons, at 12*s.*, eqnal 5,400,000*l.*, it follows that the by-products exceed in value the coal used by very nearly 3,000,000*l.*

In using raw coal for heating purposes these valuable products are not only absolutely lost to us, but in their stead we are favoured with those semi-gaseous by-products in the atmosphere too well known to the denizens of London and other large towns as smoke. Professor Roberts has calculated that the soot in the pall hanging over London on a winter's day amounts to fifty tons, and that the carbonic oxide, a poisonous compound, resulting from the imperfect combustion of coal, may be taken as at least five times that amount. Mr. Aitken has shown, moreover, in an interesting paper communicated to the Royal Society of Edinburgh, last year, that the fine dust resulting from the imperfect combustion of coal is mainly instrumental in the formation of fog; each particle of solid matter attracting to itself aqueous vapour, these globules of fog are rendered particularly tenacious and disagreeable by the presence of tar vapour, another result of imperfect combustion of raw fuel, which might be turned to much better account at the dye-works. The hurtful influence of smoke upon public health, the great personal discomfort to which it gives rise, and the vast expense it indirectly causes through the destruction of our monuments, pictures, furniture, and apparel, are now being recognised, as is evinced by the success of recent Smoke Abatement Exhibitions. The most effectual remedy would result from a general recognition of the fact that wherever smoke is produced, fuel is being consumed wastefully, and that all our calorific effects, from the largest down to the domestic fire, can be realised as completely and more economically, without allowing any of the fuel employed to reach the atmosphere unburnt. This most desirable result may be effected by the use of gas for all heating purposes with or without the addition of coke or anthracite.

The cheapest form of gas is that obtained through the entire distillation of fuel in such gas producers as are now largely used in working the furnaces of glass, iron, and steel works; but gas of this description would not be available for the supply of towns owing to its bulk, about two-thirds of its volume being nitrogen. The use of water-gas, resulting from the decomposition of steam in passing through a hot chamber filled with coke, has been suggested, but this gas also is objectionable, because it contains, besides hydrogen, the poisonous and inodorous gas carbonic oxide, the introduction of which into dwelling-houses could not be effected without considerable danger. A more satisfactory mode of supplying heating separately from illuminating gas would consist in connecting the retort at different periods of the distillation with two separate systems of mains for the delivery of the respective gases. Experiments made some years ago by Mr. Ellisen of the Paris gasworks have shown that the gases rich in carbon, such as olefiant and acetylene, are developed chiefly during an interval of time, beginning half an hour after the commencement and terminating at half the whole period of distillation, whilst during the remainder of the time, marsh gas and hydrogen are chiefly developed, which, while possessing little illuminating power are most advantageous for heating purposes, By resorting to improved means of heating the retorts with gaseous fuel, such as have been in use at the Paris gasworks for a considerable number of years, the length of time for effecting each distillation may be shortened from six hours, the usual period in former years, to four, or even three hours, as now practised at Glasgow and elsewhere. By this means a given number of retorts can be made to produce, in addition to the former quantity of illuminating gas of superior quality, a similar quantity of heating gas, resulting in a diminished cost of production and an increased supply of the valuable by-products previously referred to. The quantity of both ammonia and heating gas may be further increased by the simple expedient of passing a streamlet of steam through the heated retorts towards the end of each operation, whereby the ammonia and hydrocarbons still occluded in the heated coke will be evolved, and the volume of heating gas produced be augmented by the products of decomposition of the steam itself. It has been shown that gas may be used advantageously for domestic purposes with judicious management even under present conditions, and it is easy to conceive that its consumption for heating would soon increase, perhaps tenfold, if supplied separately at say 1*s.* a thousand cubic feet. At this price gas would be not only the cleanest and most convenient, but also the cheapest form of fuel, and the enormous increase of consumption, the superior quality of the illuminating gas obtained by selection, and the proportionate increase of by-products, would amply compensate the gas company or corporation for the comparatively low price of the heating gas.

The greater efficiency of gas as a fuel results chiefly from the circumstance that a pound of gas yields in combustion 22,000 heat units, or exactly double the heat produced in the combustion of a pound of ordinary coal. This extra heating power is due partly to the freedom of the gas from earthy constituents, but chiefly to the heat imparted to it in effecting its distillation. Recent experiments with gas-burners have shown that in this direction also there is much room for improvement.

The amount of light given out by a gas flame depends upon the temperature to which the particles of solid carbon in the flame are raised, and Dr. Tyndall has shown that of the radiant energy set up in such a flame, only the $\frac{1}{25}$th part is luminous; the hot products of combustion carry off at least four times as much energy as is radiated, so that not more than one hundredth part of the heat evolved in combustion is converted into light. This proportion could be improved, however, by increasing the temperature of combustion, which may be effected either by intensified air currents or by regenerative action. Supposing that the heat of the products of combustion could be communicated to metallic surfaces, and be transferred by conduction or otherwise to the atmospheric air supporting combustion in the flame, we should be able to increase the temperature accumulatively to any point within the limit of dissociation; this limit may be fixed at about 2,300° C., and cannot be very much below that of the electric arc. At such a temperature the proportion of luminous rays to the total heat produced in combustion would be more than doubled, and the brilliancy of the light would at the same time be greatly increased. Thus improved, gas-lighting may continue its rivalry with electric lighting both as regards economy and brilliancy, and such rivalry must necessarily result in great public advantage.

In the domestic grate radiant energy of inferior intensity is required, and I for one do not agree with those who would like to see the open fireplace of this country, superseded by the continental stove. The advantages usually claimed for the open fireplace are, that it is cheerful, "pokable," and conducive to ventilation, but to these may be added another of even greater importance, viz., that the radiant heat which it emits passes through the transparent air without warming it, and imparts heat only to the solid walls, floor, and furniture of the room, which are thus constituted the heating surfaces of the comparatively cool air of the apartments in contact with them. In the case of stoves the heated air of the room causes deposit of moisture upon the walls in heating them, and gives rise to mildew and germs injurious to health. It is, I think, owing to this circumstance that upon entering an apartment one can immediately perceive whether or not it is heated by an open fireplace; nor is the unpleasant sensation due to stove-heating completely removed by mechanical ventilation; there is, moreover, no good reason why an open fireplace should not be made as economical and smokeless as a stove or hot-water apparatus.

In the production of mechanical effect from heat, gaseous fuel also presents most striking advantages, as will appear from the following consideration. When we have to deal with the question of converting mechanical into electrical effect, or *vice versâ*, by means of the dynamo-electrical machine, we have only to consider what are the equivalent values of the two forms of energy, and what precautions are necessary to avoid losses by the electrical resistance of conductors and by friction. The transformation of mechanical effect into heat involves no losses except those resulting from imperfect installation, and these may be so completely avoided that Dr. Joule was able by this method to determine the equivalent values of the two forms of energy. But in attempting the inverse operation of effecting the conversion of heat into mechanical energy, we find ourselves confronted by the second law of thermo-dynamics, which says that whenever a given amount of heat is converted into mechanical effect, another but variable amount descends from a higher to a lower potential, and is thus rendered unavailable.

In the condensing steam engine this waste heat comprises that communicated to the condensing water, whilst the useful heat, or that converted into mechanical effect, depends upon the difference of temperature between the boiler and condenser. The boiler pressure is limited, however, by considerations of safety and convenience of construction, and the range of working temperature rarely exceeds 120° C. except in the engines constructed by Mr. Perkins, in which a range of 160° C., or an expansive action commencing at 14 atmospheres, has been adopted with considerable promise of success, as appears from an able report on this engine by Sir Frederick Bramwell. To obtain more advantageous primary conditions we have to turn to the caloric or gas engine, because in them the co-efficient of efficiency expressed by $\frac{T-T'}{T}$ may be greatly increased. This value would reach a maximum if the initial absolute temperature T could be raised to that of combustion, and T' reduced to atmospheric temperature, and these maximum limits can be much more nearly approached in the gas engine worked by a combustible mixture of air and hydro-carbons than in the steam engine.

Assuming, then, in an explosive gas-engine a temperature of 1,500° C. at a pressure of 4 atmospheres, we should, in accordance with the second law of thermo-dynamics, find a temperature after expansion to atmospheric pressure of 600° C., and therefore a working range of 1500° – 600° = 900°, and a theoretical efficiency $\frac{900}{1500 + 274}$ = about one-half, contrasting very favourably with that of a good expansive condensing steam-engine, in which the range is 150 – 30 = 120° C., and the efficiency $\frac{120}{150 + 274} = \frac{2}{7}$. A good expansive steam-engine is therefore capable of yielding as mechanical work $\frac{2}{7}$th part of the heat communicated to the boiler, which does not include the heat lost by imperfect combustion, and that carried away in the chimney. Adding to these, the losses by friction and radiation in the engine, we find that the best steam-engine yet constructed does not yield in mechanical effect more than $\frac{1}{7}$th part of the heat energy residing in the fuel consumed. In the gas-engine we have also to make reductions from the theoretical efficiency, on account of the rather serious loss of heat by absorption into the working cylinder, which has to be cooled artificially in order to keep its temperature down to a point at which lubrication is possible; this, together with frictional loss, cannot be taken at less than one-half, and reduces the factor of efficiency of the engine to $\frac{1}{4}$th.

It follows from these considerations that the gas or caloric engine combines the conditions most favourable to the attainment of maximum results, and it may reasonably be supposed that the difficulties still in the way of their application on a large scale will gradually be removed. Before many years have elapsed we may find in our factories and on board our ships engines with a fuel consumption not exceeding one pound of coal per effective horse power per hour, in which the gas producer takes the place of the somewhat complex and dangerous steam boiler. The advent of such an engine and of the dynamo-machine must mark a new era of material progress at least equal to that produced by the introduction of steam power in the early part of our century. Let us consider what would be the probable effect of such an engine upon that most important interest of this country—the merchant navy.

According to returns kindly furnished by the Board of Trade and *Lloyds' Register of Shipping*, the total value of the merchant shipping of the United Kingdom may be estimated at 126,000,000*l*., of which 90,000,000*l*. represents steamer having a net tonnage of 3,003,988 tons; and 36,000,000*l*. sailing vessels, of 3,688,008 tons. The safety of this vast amount of shipping, carrying about five-sevenths of our total imports and exports, or 500,000,000*l*. of goods in the year, and of the more precious lives connected with it, is a question of paramount importance. It involves considerations of the most varied kind: comprising the construction of the vessel itself, and the material employed in building it; its furniture of engines, pumps, sails, tackle, compass, sextant, and sounding apparatus, the preparation of reliable charts for the guidance of the navigator, and the construction of harbours of refuge, lighthouses, beacons, bells, and buoys, for channel navigation. Yet notwithstanding the combined efforts of science, inventive skill, and practical experience—the accumulation of centuries—we are startled with statements to the effect that during last year as many as 1,007 British owned ships were lost, of which fully two-thirds were wrecked upon our shores, representing a total value of nearly 10,000,000*l*. Of these ships 870 were sailing vessels and 137 steamers, the loss of the latter being in a fourth of the cases attributable to collision. The number of sailing vessels included in these returns being 19,325, and of steamers 5,505, it appears that the steamer is the safer vessel, in the proportion of 4·43 to 3·46; but the steamer makes on an average three voyage for one of the sailing ship taken over the year, which reduces the relative risk of the steamer as compared with the sailing ship per voyage in the proportion of 13·29 to 3·46. Commercially speaking, this factor of safety in favour of steam-shipping is to a great extent counterbalanced by the value of the steamship, which bears to that of the sailing vessel per net carrying ton the proportion of 3 : 1, thus reducing the ratio in favour of steam shipping as 13·29 to 10·38, or in round numbers as 4 : 3. In testing this result by the charges of premium for insurance, the variable circumstances of distance, nature of cargo, season and voyage have to be taken into account; but judging from information received from shipowners and underwriters of undoubted authority, I find that the relative insurance paid for the two classes of vessel represents an average of 30 per cent. in favour of steam shipping, agreeing very closely with the above deductions derived from statistical information.

In considering the question how the advantages thus established in favour of steam-shipping could be further improved, attention should be called in the first place to the material employed in their construction. A new material was introduced for this purpose by the Admiralty in 1876—78, when they constructed at Pembroke dockyard the two steam corvettes, the *Iris* and *Mercury*, of mild steel. The peculiar qualities of this material are such as to have enabled shipbuilders to save 20 per cent. in the weight of the ship's hull, and to increase to that extent its carrying capacity. It combines with a strength 30 per cent. superior to that of iron such extreme toughness, that in the case of collision the side of the vessel has been found to yield or bulge several feet without showing any sign of rupture, a quality affecting the question of sea risk very favourably. When to the use of this material there are added the advantages derived from a double bottom, and from the division of the ship's hold by means of bulkheads of solid construction, it is difficult to conceive how such a vessel could perish by collision either with another vessel or with a sunken rock. The spaces between the two bottoms are not lost, because they form convenient chambers for water ballast, but powerful pumps should in all cases be added to meet emergencies.

The following statement of the number and tonnage of vessels building and preparing to be built in the United Kingdom on the 30th of June last, which has been kindly furnished me by Lloyd's, is of interest as showing that wooden ships are fast becoming obsolete, and that even iron is beginning to yield its place, both as regards steamers and sailing ships, to the new material mild steel; it also shows that by far the greater number of vessels now building are ships of large dimensions propelled by engine power:—

	MILD STEEL.		IRON.		WOOD.		TOTAL.	
	No.	Tons gross.	No.	Tons gross.	No.	Tons gross.	No.	Tons gross.
Steam	89	159,751	555	929,921	6	460	650	1,090.132
Sailing	11	16,800	70	120,259	49	4,635	130	141,694
	100	176,551	625	1,050,180	55	5,095	780	1,231,826

If to the improvements already achieved could be added an engine of half the weight of the present steam engine and boilers, and working with only half the present expenditure of fuel, a further addition of 30 per cent. could be made to the cargo of an Atlantic propeller vessel—no longer to be called a steamer—and the balance of advantages in favour of such vessels would be sufficient to restrict the use of sailing craft chiefly to the regattas of this and neighbouring ports.

The admirable work on the "British Navy," lately published by Sir Thomas Brassey, the Civil Chief Lord of the Admiralty, shows that the naval department of this country is fully alive to all improvements having regard to the safety as well as to the fighting qualities of Her Majesty's ships of war, and recent experience goes far to prove that although high speed and manœuvring qualities are of the utmost value, the armour plate which appeared to be fast sinking in public favour is not without its value in actual warfare.

The progressive views perceptible in the construction of the navy are further evidenced in a remarkable degree in the hydrographic department. Captain Sir Frederick Evans, the hydrographer, and Vice-President of the British Association, gave us at York last year a very interesting account of the progress made in that department, which, while dealing chiefly with the preparation of charts showing the depth of water, the direction and force of currents, and the rise of tides near our shores, contains also valuable statistical information regarding the more general questions of the physical conditions of the sea, its temperature at various depths, its flora and fauna, as also the rainfall and the nature and force of prevailing winds. In connection with this subject the American Naval Department has taken an important part, under the guidance of Captain Maury and the Agassiz father and son, whilst in this country the persistent labours of Dr. William Carpenter deserve the highest consideration.

Our knowledge of tidal action has received a most powerful impulse through the invention of a self-recording gauge and tide-predicter, which will form the subject of one of the discourses to be delivered at our present meeting by its principal originator, Sir William Thomson; when I hope he will furnish us with an explanation of some extraordinary irregularities in tidal records, observed some years ago by Sir John Coode at Portland, and due apparently to atmospheric influence.

The application of iron and steel in naval construction rendered the use of the compass for some time illusory, but in 1839 Sir George Airy showed how the errors of the compass due to the influence experienced from the iron of the ship, may be perfectly corrected by magnets and soft iron placed in the neighbourhood of the binnacle, but the great size of the needles in the ordinary compasses rendered the correction of the quadrantal errors practically unattainable. In 1876 Sir William Thomson invented a compass with much smaller needles than those previously used, which allows Sir George Airy's principles to be applied completely. With this compass correctors can be arranged so that the needle shall point accurately in all directions, and these correctors can be adjusted at sea from time to time, so as to eliminate any error which may arise through change in the ship's magnetism or in the magnetism induced by the earth through change of the ship's position. By giving the compass card a long period of free oscillation great steadiness is obtained when the ship is rolling.

Sir William Thomson has also enriched the art of navigation by the invention of two sounding machines; the one being devised for ascertaining great depths very accurately in less than one-quarter the time formerly necessary, and the other for taking depths up to 130 fathoms without stopping the ship in its onward course. In both these instruments steel pianoforte wire is used instead of the hempen and silken lines formerly employed; in the latter machine the record of depth is obtained not by the quantity of wire run over its counter and brake wheel, but through the indications produced upon a simple pressure gauge consisting of an inverted glass tube, whose internal surface is covered beforehand with a preparation of chromate of silver rendered colourless by the sea-water up to the height to which it penetrates. The value of this instrument for guiding the navigator within what he calls "soundings" can hardly be exaggerated; with the sounding machine and a good chart he can generally make out his position correctly by a succession of three or four casts in a given direction at given intervals, and thus in foggy weather is made independent of astronomical observations and of the sight of lighthouses or the shore. By the proper use of this apparatus, such accidents as happened to the mail steamer *Mosel* not a fortnight ago would not be possible. As regards the value of the deep-sea instrument I can speak from personal experience, as on one occasion it enabled those in charge of the Cable s.s. *Faraday* to find the end of an Atlantic Cable, which had parted in a gale of wind, with no other indication of the locality than a single sounding, giving a depth of 950 fathoms. To recover the cable a number of soundings in the supposed neighbourhood of the broken end were taken, the 950 fathom contour line was then traced upon a chart, and the vessel thereupon trailed its grapnel two miles to the eastward of this line, when it soon engaged the cable 20 miles away from the point, where dead reckoning had placed the ruptured end.

Whether or not it will ever be practicable to determine oceanic depths without a sounding line, by means of an instrument based upon gravimetric differences, remains to be seen. Hitherto the indications obtained by such an instrument have been encouraging, but its delicacy has been such as to unfit it for ordinary use on board a ship when rolling.

The time allowed me for addressing you on this occasion is wholly insufficient to do justice to the great engineering works of the present day, and I must therefore limit myself to making a short allusion to a few only of the more remarkable enterprises.

The great success, both technically and commercially, of the Suez Canal, has stimulated M. de Lesseps to undertake a similar work of even more gigantic proportions, namely, the piercing of the Isthmus of Panama by a ship canal, 40 miles long, 50 yards wide on the surface, and 20 yards at the bottom, upon a dead level from sea to sea. The estimated cost of this work is 20,000,000*l*., and more than this sum having been subscribed, it appears unlikely that political or climatic difficulties will stop

M. de Lesseps in its speedy accomplishment. Through it, China, Japan, and the whole of the Pacific Ocean will be brought to half their present distance, as measured by the length of voyage, and an impulse to navigation and to progress will thus be given which it will be difficult to over-estimate.

Side by side with this gigantic work, Captain Eads, the successful improver of the Mississippi navigation, intends to erect his ship-railway, to take the largest vessels, fully laden and equipped, from sea to sea, over a gigantic railway across the Isthmus of Tehuantepec, a distance of ninety-five miles. Mr. Barnaby, the chief constructor of the navy, and Mr. John Fowler have expressed a favourable opinion regarding this enterprise, and it is to be hoped that both the canal and the ship-railway will be accomplished, as it may be safely anticipated that the traffic will be amply sufficient to support both these undertakings.

Whether or not M. de Lesseps will be successful also in carrying into effect the third great enterprise with which his name has been prominently connected, the flooding of the Tunis-Algerian Chotts, thereby re-establishing the Lake Tritonis of the ancients, with its verdure clad shores, is a question which could only be decided upon the evidence of accurate surveys, but the beneficial influence of a large sheet of water within the African desert could hardly be matter of doubt.

It is with a feeling not unmixed with regret that I have to record the completion of a new Eddystone Lighthouse in substitution for the *chef-d'œuvre* of engineering erected by John Smeaton more than 100 years ago. The condemnation of that structure was not, however, the consequence of any fault of construction, but was caused by inroads of the sea upon the rock supporting it. The new lighthouse, designed and executed by Mr., now Sir James Douglas, engineer of Trinity House, has been erected in the incredibly short time of less than two years, and bids fair to be worthy of its famed predecessor. Its height above high water is 130 feet, as compared with 72 feet, the height of Telford's structure, which gives its powerful light a considerably increased range. The system originally suggested by Sir William Thomson some years ago, of distinguishing one light from another by flashes following at varied intervals, has been adopted by the Elder Brethren in this as in other recent lights in the modified form introduced by Dr. John Hopkinson, in which the principle is applied to revolving lights, so as to obtain a greater amount of light in the flash.

The geological difficulties which for sometime threatened the accomplishment of the St. Gothard Tunnel, have been happily overcome, and this second and most important sub-Alpine thoroughfare now connects the Italian railway system with that of Switzerland and the south of Germany, whereby Genoa will be constituted the shipping port for those parts.

Whether we shall be able to connect the English with the French railway system by means of a tunnel below the English Channel is a question that appears dependent at this moment rather upon military and political than technical and financial considerations. The occurrence of a stratum of impervious grey chalk, at a convenient depth below the bed of the Channel, minimises the engineering difficulties in the way, and must influence the financial question involved. The protest lately raised against its accomplishment can hardly be looked upon as a public verdict, but seems to be the result of a natural desire to pause pending the institution of careful inquiries. These inquiries have been made by a Royal Scientific Commission, and will be referred for further consideration to a mixed Parliamentary Committee, upon whose Report it must depend whether the natural spirit of commercial enterprise has to yield in this instance to political and military considerations. Whether the Channel Tunnel is constructed or not, the plan proposed some years ago by Mr. John Fowler of connecting England and France by means of a ferry boat capable of taking railway trains would be a desideratum justified by the ever-increasing intercommunication between this and Continental countries.

The public inconvenience arising through the obstruction to traffic by a sheet of water is well illustrated by the circumstance that both the estuaries of the Severn and of the Mersey are being undermined in order to connect the railway systems on the two sides, and that the Frith of Forth is about to be spanned by a bridge exceeding in grandeur anything as yet attempted by the engineer. The roadway of this bridge will stand 150 feet above high-water mark, and its two principal spans will measure a third of a statute mile each. Messrs. Fowler and Baker, the engineers to whom this great work has been entrusted, could hardly have accomplished their task without having recourse to steel for their material of construction, nor need the steel used be of the extra mild quality particularly applicable for naval structures to withstand collision, for, when such extreme toughness is not required, steel of very homogeneous quality can be produced, bearing a tensile strain double that of iron.

The tensile strength of steel, as is well known, is the result of an admixture of carbon with the iron, varying between $\frac{1}{10}$th and 2 per cent., and the nature of this combination of carbon with iron is a matter of great interest both from a theoretical and practical point of view. It could not be a chemical compound which would necessitate a definite proportion, nor could a mere dissolution of the one in the other exercise such remarkable influence upon the strength and hardness of the resulting metal. A recent investigation by Mr. Abel has thrown considerable light upon this question. A definite carbide of iron is formed, it appears, soluble at high temperatures in iron, but separating upon cooling the steel gradually, and influencing only to a moderate degree the physical properties of the metal as a whole. In cooling rapidly there is no time for the carbide to separate from the iron, and the metal is thus rendered both hard and brittle. Cooling the metal gradually under the influence of great compressive force, appears to have a similar effect to rapid cooling in preventing the separation of the carbide from the metal, with this difference, that the effect is more equal throughout the mass, and that more uniform temper is likely to result.

When the British Association met at Southampton on a former occasion, Schönbein announced to the world his discovery of gun-cotton. This discovery has led the way to many valuable researches on explosives generally, in which Mr. Abel has taken a leading part. Recent investigations by him, in connection with Captain Noble, upon the explosive action of gun-cotton and gunpowder confined in a strong chamber, which have not yet been published, deserve particular attention. They show that while by the method of investigation pursued about twenty years ago by Karolye (of exploding gunpowder in very small charges in shells confined within a large shell partially exhausted of air), the composition of the gaseous products was found to be complicated and liable to variation, the chemical metamorphosis which gun-cotton sustains, when exploded under conditions such as obtain in its practical application, is simple and very uniform. Among other interesting points noticed in this direction was the fact that, as in the case of gunpowder, the proportion of carbonic acid increases, while that of carbonic oxide diminishes with the density of the charge. The explosion of gun-cotton, whether in the form of wool or loosely spun thread, or in the packed compressed form devised by Abel, furnished practically the same results if fired under pressure, that is, under strong confinement —the conditions being favourable to the full development of its explosive force; but some marked differences in the composition of the products of metamorphosis were observed when gun-cotton was fired by detonation. With regard to the tension exerted by the products of explosion, some interesting points were observed, which introduce very considerable difficulties into the investigation of the action of fired gun-cotton. Thus whereas no marked differences are observed in the tension developed by small charges and by very much larger charges of gunpowder having the same density (*i.e.*, occupying the same volume relatively to the entire space in which they are exploded) the reverse is the case with respect to gun-cotton. Under similar conditions in regard to density of charge, 100 grammes of gun-cotton gave a measured tension of about 20 tons on the square inch, 1,500 grammes gave a tension of about 29 tons (in several very concordant observations), while a charge of 2·5 kilos gave a pressure of about 45 tons, this being the maximum measured tension obtained with a charge of gunpowder of five times the density of the above.

The extreme violence of the explosion of gun cotton as compared with gunpowder when fired in a closed space was a feature attended with formidable difficulties. In whatever way the charge was arranged in the firing cylinder, if it had free access to the enclosed crusher gauge, the pressures recorded by the latter were always much greater than when means were taken to prevent the wave of matter suddenly set in motion from acting directly upon the gauge. The abnormal or wave-pressures recorded at the same time that the general tension in the cylinder was measured amounted in the experiment to 42·3 tons, when the general tension was recorded at 20 tons; and in another when the pressure was measured at 29 ton, the wave-pressure recorded was 44 tons. Measurements of the temperature of explosion of gun-cotton showed it to be about double that of the explosion of gunpowder. One of the effects observed to be produced by this sudden enormous development of heat was the covering of the inner surfaces of the steel explosion-vessel with a net-work of cracks, small portions of the surface being sometimes actually fractured. The explosion of charges of gun-cotton up to 2·5 kilos in perfectly closed chambers, with development of pressures approaching to 50 tons on the square inch, constitutes alone a perfectly novel feat in investigations of this class.

Messrs. Noble and Abel are also continuing their researches upon fired gunpowder, being at present occupied with an inquiry into the influence exerted upon the chemical metamorphosis and ballistic effects of fired gunpowder by variation in its composition, their attention being directed especially to the discovery of the cause of the more or less considerable erosion of the interior surface of guns produced by the exploding charge—an effect which, notwithstanding the application of devices in the building up of the charge specially directed to the preservation of the gun's bore, have become so serious that, with the enormous charges now used in our heavy guns, the erosive action on the surface of the bore produced by a single round is distinctly perceptible. As there appeared to be *primâ facie* reasons why the erosive action of powder upon the surface of the bore at the high temperatures developed should be at any rate in part due to its one component sulphur, Noble and Abel have made comparative experiments with powders of usual composition and with others in which the proportion of sulphur was considerably increased, the extent of erosive action of the products escaping from the explosion vessel under high tension being carefully determined. With small charges a particular powder containing no sulphur was found to exert very little erosive action as compared with ordinary cannon powder; but another powder, containing the maximum proportion of sulphur tried (15 per cent.), was found equal to it under these conditions. and exerted very decidedly less erosive action than it, when larger charges were reached. Other important contributions to our knowledge of the action of fired gunpowder in guns, as well as decided improvements in the gunpowder manufactured for the very heavy ordnance of the present day, may be expected to result from a continuance of these investigations. Prof. Carl Himly, of Kiel, having been engaged upon investigations of a similar nature, has lately proposed a gunpowder in which hydrocarbons precipitated from solution in naphtha take the place of the charcoal and sulphur of ordinary powder, this powder has amongst others the peculiar property ot completely resisting the action of water, so that the old caution, "Keep your powder dry," may hereafter be unnecessary.

The extraordinary difference of condition, before and after its ignition, of such matter as constitutes an explosive agent leads us up to a consideration of the aggregate state of matter under other circumstances. As early as 1776 Alexander Volta observed that the volume of glass was changed under the influence of electrification, by what he termed electrical pressure. Dr. Kerr, Govi, and others have followed up the same inquiry, which is at present continued chiefly by Dr. George Quincke, of Heidelberg, who finds that temperature, as well as chemical constitution of the dielectric under examination, exercises a determining influence upon the amount and character of the change of volume effected by electrification; that the change of volume may under certain circumstances be effected instantaneously as in flint glass, or only slowly as in crown glass, and that the elastic limit of both is diminished by electrification, whereas in the case of mica and of guttapercha an increase of elasticity takes place.

Still greater strides are being made at the present time towards a clearer perception of the condition of matter when particles are left some liberty to obey individually the forces brought to bear upon them. By the discharge of high tension electricity through tubes containing highly rarefied gases (Geissler's tubes), phenomena of discharge were produced which were at once most striking and suggestive. The Sprengel pump afforded a means of pushing the exhaustion to limits which had formerly been scarcely reached by the imagination. At each step the condition of attenuated matter revealed varying properties when acted upon by electrical discharge and magnetic force. The radiometer of Crookes imported a new feature into these inquiries, which at the present time occupy the attention of leading physicists in all countries.

The means usually employed to produce electrical discharge in vacuum tubes was Ruhmkorff's coil; but Mr. Gassiot first succeeded in obtaining the phenomena by means of a galvanic battery of 3000 Leclanché cells. Dr. De La Rue, in conjunction with his friend Dr. Hugo Müller, has gone far beyond his predecessors in the production of batteries of high potential. At his lecture "On the phenomena of electrical discharge," delivered at the Royal Institution in January 1881, he employed a battery of his invention consisting of 14,400 cells (14,832 Volts), which gave a current of 0·054 Ampère, and produced a discharge at a distance of 0·71 inch between the terminals. During last year he increased the number of cells to 15,000 (15,450 Volts), and increased the current to 0·4 Ampère or eight times that of the battery he used at the Royal Institution.

With the enormous potential and perfectly steady current at his disposal, Mr. De La Rue has been able to contribute many interesting facts to the science of electricity. He has shown, for example, that the beautiful phenomena of the stratified discharge in exhausted tubes are but a modification and a magnification of those of the electric arc at ordinary atmospheric pressure. Photography was used in his experiments to record the appearance of the discharge, so as to give a degree of precision otherwise unattainable in the comparison of the phenomena. He has shown that between two points the length of the spark, provided the insulation of the battery is efficacious, is as the square of the number of cells employed. Mr. De La Rue's experiments have proved that at all pressures the discharge in gases is not a current in the ordinary acceptation of the term, but is of the nature of a disruptive discharge. Even in an apparently perfectly steady discharge in a vacuum tube, when the strata as seen in a rapidly revolving mirror are immovable, he has shown that the discharge is a pulsating one; but, of course, the period must be of a very high order.

At the Royal Institution, on the occasion of his lecture, Mr. De La Rue produced, in a very large vacuum tube, an imitation of the aurora borealis; and he has deduced from his experiments that the greatest brilliancy of aurora displays must be at an altitude of from thirty-seven to thirty-eight miles—a conclusion of the highest interest, and in opposition to the extravagant estimate of 281 miles at which it had been previously put.

The President of the Royal Society has made the phenomena of electrical discharge his study for several years, and resorted in his important experiments to a special source of electric power. In a note addressed to me, Dr. Spottiswoode describes the nature of his investigations much more clearly than I could venture to give them. He says: "It had long been my opinion that the dissymmetry shown in electrical discharges through rarefied gases must be an essential element of every disruptive discharge, and that the phenomena of stratification might be regarded as magnified images of features always present, but concealed under ordinary circumstances. It was with a view to the study of this question that the researches by Moulton and myself were undertaken. The method chiefly used consisted in introducing into the circuit intermittence of a particular kind, whereby one luminous discharge was rendered sensitive to the approach of a conductor outside the tube. The application of this method enabled us to produce artificially a variety of phenomena, including that of stratification. We were thus led to a series of conclusions relating to the mechanism of the discharge, among which the following may be mentioned:—

1. That a stria, with its attendant dark space, forms a physical unit of a striated discharge; that a striated column is an aggregate of such units formed by means of a step-by-step process; and that the negative glow is merely a localised stria, modified by local circumstances.

2. That the origin of the luminous column is to be sought for at its negative end; that the luminosity is an expression of a demand for negative electricity; and that the dark spaces are those regions where the negative terminal, whether metallic or gaseous, is capable of exerting sufficient influence to prevent such demand.

3. That the time occupied by electricity of either name in traversing a tube is greater than that occupied in traversing an equal length of wire, but less than that occupied by molecular streams (Crooke's radiations) in traversing the tubes. Also that, especially in high vacua, the discharge from the negative terminal exhibits a durational character not found at the positive.

4. That the brilliancy of the light with so little heat may be due in part to brevity in the duration of the discharge; and that for action so rapid as that of individual discharges, the mobility of the medium may count as nothing; and that for these infini-

tesimal periods of time gas may itself be as rigid and as brittle as glass.

5. That striæ are not merely loci in which electrical is converted into luminous energy, but are actual aggregations of matter.

This last conclusion was based mainly upon experiments made with an induction coil excited in a new way—viz. directly by an alternating machine, without the intervention of a commutator or condenser. This mode of excitement promises to be one of great importance in spectroscopic work, as well as in the study of the discharge in a magnetic field, partly on account of the simplification which it permits in the construction of induction coils, but mainly on account of the very great increase of strength in the secondary currents to which it gives rise.

These investigations assume additional importance when we view them in connection with solar—I may even say stellar—physics, for evidence is augmenting in favour of the view that interstellar space is not empty, but is filled with highly attenuated matter of a nature such as may be put into our vacuum tubes. Nor can the matter occupying stellar space be said any longer to be beyond our reach for chemical and physical test. The spectroscope has already thrown a flood of light upon the chemical constitution and physical condition of the sun, the stars, the comets, and the far distant nebulæ, which have yielded spectroscopic photographs under the skilful management of Dr. Huggins, and Dr. Draper of New York. Armed with greatly improved apparatus, the physical astronomer has been able to reap a rich harvest of scientific information during the short periods of the last two solar eclipses—that of 1879, visible in America, and that of May last, observed in Egypt by Lockyer, Schuster, and by Continental observers of high standing. The result of this last eclipse expedition has been summed up as follows:—"Different temperature levels have been discovered in the solar atmosphere; the constitution of the corona has now the possibility of being determined, and it is proved to shine with its own light. A suspicion has been aroused once more as to the existence of a lunar atmosphere, and the position of an important line has been discovered. Hydro-carbons do not exist close to the sun, but may in space between us and it."

To me personally these reported results possess peculiar interest, for in March last I ventured to bring before the Royal Society a speculation regarding the conservation of solar energy, which was based upon the three following postulates, viz.:—

1. That aqueous vapour and carbon compounds are present in stellar or interplanetary space.

2. That these gaseous compounds are capable of being dissociated by radiant solar energy while in a state of extreme attenuation.

3. That the effect of solar rotation is to draw in dissociated vapours upon the polar surfaces, and to eject them after combustion has taken place back into space equatorially.

It is therefore a matter of peculiar gratification to me that the results of observation here recorded give considerable support to that speculation. The luminous equatorial extensions of the sun which the American observations revealed in such a striking manner (with which I was not acquainted when writing my paper) were absent in Egypt; but the outflowing equatorial streams I suppose to exist could only be rendered visible by reflected sunlight, when mixed with dust produced by exceptional solar disturbances or by electric discharge; and the occasional appearance of such luminous extensions would serve only to disprove the hypothesis entertained by some, that they are divided planetary matter, in which case their appearance should be permanent. Prof. Langley, of Pittsburg, has shown, by means of his bolometer, that the solar actinic rays are absorbed chiefly in the solar instead of in the terrestrial atmosphere, and Capt. Abney has found by his new photometric method that absorption due to hydrocarbons takes place somewhere between the solar and terrestrial atmosphere; in order to test this interesting result still further, he has lately taken his apparatus to the top of the Riffel with a view of diminishing the amount of terrestrial atmospheric air between it and the sun, and intends to bring a paper on this subject before Section A. Stellar space filled with such matter as hydrocarbon and aqueous vapour would establish a material continuity between the sun and his planets, and between the innumerable solar systems of which the universe is composed. If chemical action and reaction can further be admitted, we may be able to trace certain conditions of thermal dependence and maintenance, in which we may recognise principles of high perfection, applicable also to comparatively humble purposes of human life.

We shall thus find that in the great workshop of nature there are no lines of demarcation to be drawn between the most exalted speculation and common-place practice, and that all knowledge must lead up to one great result, that of an intelligent recognition of the Creator through His works. So then, we members of the British Association and fellow-workers in every branch of science may exhort one another in the words of the American bard who has so lately departed from amongst us:—

"Let us then be up and doing,
With a heart for any fate;
Still achieving, still pursuing,
Learn to labour and to wait."

SECTION A

MATHEMATICAL AND PHYSICAL

Opening Address by the Right Hon. Lord Rayleigh, M.A., F.R.S., F.R.A.S, President of the Section

In common with some of my predecessors in this chair, I recognise that probably the most useful form which a presidential address could take, would be a summary of the progress of physics, or of some important branch of physics, during recent years. But the difficulties of such a task are considerable, and I do not feel myself equal to grappling with them. The few remarks which I have to offer are of a general, I fear it may be thought of a commonplace character. All I can hope is that they may have the effect of leading us into a frame of mind suitable for the work that lies before us.

The diversity of the subjects which come under our notice in this section, as well as of the methods by which alone they can be adequately dealt with, although a sign of the importance of our work, is a source of considerable difficulty in the conduct of it. From the almost inevitable specialisation of modern science, it has come about that much that is familiar to one member of our section is unintelligible to another, and that details whose importance is obvious to the one fail altogether to rouse any interest in the mind of the other. I must appeal to the authors of papers to bear this difficulty in mind, and to confine within moderate limits their discussion of points of less general interest.

Even within the limits of those departments whose foundation is evidently experimental, there is room, and indeed necessity, for great variety of treatment. One class of investigators relies mainly upon reiterated appeals to experiment to resolve the questions which appear still to be open, while another prefers, with Thomas Young, to base its decisions as far as possible upon deductions from experiments already made by others. It is scarcely necessary to say that in the present state of science both methods are indispensable. Even where we may fairly suppose that the fundamental principles are well established, careful and often troublesome work is necessary to determine with accuracy the constants which enter into the expression of natural laws. In many cases the accuracy desirable, even from a practical point of view, is hard to attain. In many others, where the interest is mainly theoretical, we cannot afford to neglect the confirmations which our views may derive from the comparison of measurements made in different fields and in face of different experimental difficulties. Examples of the inter-dependence of measurements apparently distinct will occur to every physicist. I may mention the absolute determinations of electrical resistance, and of the amounts of heat developed from electrical and mechanical work, any two of which involve also the third, and the relation of the velocity of sound to the mechanical and thermal properties of air.

Where a measurement is isolated, and not likely to lead to the solution of any open question, it is doubtless possible to spend upon it time and attention that might with advantage be otherwise bestowed. In such a case we may be properly be satisfied for a time with work of a less severe and accurate character, knowing that with the progress of knowledge the way is sure to be smoothed both by a better appreciation of the difficulties involved, and by the invention of improved experimental appliances. I hope I shall not be misunderstood as underrating the importance of great accuracy in its proper place if I express the opinion that the desire for it has sometimes had a prejudicial effect. In cases where a rough result would have sufficed for all immediate purposes, no measurement at all has been attempted, because the circumstances rendered it unlikely that a high standard of precision could be attained. Whether our aim be more or less ambitious, it is important to recognise the limitations to which our methods are necessarily subject, and as far as possible to estimate the extent to which our results are uncertain. The comparison of estimates of uncertainty made before and after the execution of a set of measurements may sometimes be humiliating, but it is always instructive.

Even when our results show no greater discrepancies than we were originally prepared for, it is well to err on the side of modesty in estimating their trustworthiness. The history of science teaches only too plainly the lesson that no single method is absolutely to be relied upon, that sources of error lurk where they are least expected, and that they may escape the notice of the most experienced and conscientious worker. It is only by the concurrence of evidence of various kinds and from various sources that practical certainty may at last be attained, and complete confidence justified. Perhaps I may be allowed to illustrate my meaning by reference to a subject which has engaged a good deal of my attention for the last two years—the absolute measurement of electrical resistance. The unit commonly employed in this country is founded upon experiments made about twenty years ago by a distinguished committee of this Association, and was intended to represent an absolute resistance of 10^9. C.G.S., *i.e.* one ohm. The method employed by the committee at the recommendation of Sir W. Thomson (it had been originally proposed by Weber) consisted in observing the deflection from the magnetic meridian of a needle suspended at the centre of a coil of insulated wire, which formed a closed circuit, and was made to revolve with uniform and known speed about a vertical axis. From the speed and deflection in combination with the mean radius of the coil and the number of its turns, the absolute resistance of the coil, and thence of any other standard, can be determined.

About ten years later Kohlrausch attacked the problem by another method, which it would take too long to explain, and arrived at the result that the B.A. unit was equal to 1·02 ohms—about two per cent. too large. Rowland, in America, by a comparison between the steady battery current flowing in a primary coil with the transient current developed in a secondary coil when the primary current is reversed, found that the B.A. unit was ·991 ohms. Lorentz, using a different method again, found ·980, while H. Weber, from distinct experiments, arrived at the conclusion that the B.A. unit was correct. It will be seen that the results obtained by these highly competent observers range over about four per cent. Two new determinations have lately been made in the Cavendish laboratory at Cambridge, one by myself with the method of the revolving coil, and another by Mr. Glazebrook, who used a modification of the method followed by Rowland, with the result that the B.A. unit is ·986 ohms. I am now engaged upon a third determination, using a method which is a modification of that of Lorentz.

In another important part of the field of experimental science, where the subject-matter is ill understood, and the work is qualitative rather than quantitative, success depends more directly upon sagacity and genius. It must be admitted that much labour spent in this kind of work is ill-directed. Bulky records of crude and uninterpreted observations are not science, nor even in many cases the raw material out of which science will be constructed. The door of experiment stands always open; and when the question is ripe, and the man is found, he will nine times out of ten find it necessary to go through the work again. Observations made by the way, and under favourable conditions, may often give rise to valuable suggestions, but these must be tested by experiment, in which the conditions are simplified to the utmost, before they can lay claim to acceptance.

When an unexpected effect is observed, the question will arise whether or not an explanation can be found upon admitted principles. Sometimes the answer can be quickly given; but more often it will happen that an assertion of what *ought* to have been expected can only be made as the result of an elaborate discussion of the circumstances of the case, and this discussion must generally be mathematical in its spirit, if not in its form. In repeating, at the beginning of the century, the well-known experiment of the inaudibility of a bell rung *in vacuo*, Leslie made the interesting observation that the presence of hydrogen was inimical to the production of sound, so that not merely was the sound less in hydrogen than in air of equal pressure, but that the actual addition of hydrogen to rarefied air caused a diminution in the intensity of sound. How is this remarkable fact to be explained? Does it prove that, as Herschel was inclined to think, a mixture of gases of widely different densities differs in its acoustical properties from a single gas? These questions could scarcely be answered satisfactorily but by a mathematical investigation of the process by which vibrations are communicated from a vibrating solid body to the surrounding gas. Such an investigation, founded exclusively upon principles well established before the date of Leslie's observation, was undertaken years afterwards by Stokes, who proved that what Leslie observed was exactly what ought to have been expected. The addition of hydrogen to attenuated air increases the wave-length of vibrations of given pitch, and consequently the facility with which the gas can pass round the edge of the bell from the advancing to the retreating face, and thus escape those rarefactions and condensations which are essential to the formation of a complete sound wave. There remains no reason for supposing that the phenomenon depends upon any other elements than the density and pressure of the gaseous atmosphere, and a direct trial, *e.g.* a comparison between air and a mixture of carbonic anhydride and hydrogen of like density, is almost superfluous.

Examples such as this, which might be multiplied *ad libitum*, show how difficult it often is for an experimenter rightly to interpret his results without the aid of mathematics. It is eminently desirable that the experimenter himself should be in a position to make the calculations, to which his work gives occasion, and from which in return he would often receive valuable hints for further experiment. I should like to see a course of mathematical instruction arranged with especial reference to physics, within which those whose bent was plainly towards experiment might, more or less completely, confine themselves. Probably a year spent judiciously on such a course would do more to qualify the student for actual work than two or three years of the usual mathematical curriculum. On the other side, it must be remembered that the human mind is limited, and that few can carry the weight of a complete mathematical armament without some repression of their energies in other directions. With many of us difficulty of remembering, if not want of time for acquiring, would impose an early limit. Here, as elsewhere, the natural advantages of a division of labour will assert themselves. Innate dexterity and facility of contrivance, backed by unflinching perseverance, may often conduct to successful discovery or invention a man who has little taste for speculation; and on the other hand the mathematician, endowed with genius and insight, may find a sufficient field for his energies in interpreting and systematising the work of others.

The different habits of mind of the two schools of physicists sometimes lead them to the adoption of antagonistic views on doubtful and difficult questions. The tendency of the purely experimental school is to rely almost exclusively upon direct evidence, even when it is obviously imperfect, and to disregard arguments which they stigmatise as theoretical. The tendency of the mathematician is to overrate the solidity of his theoretical structures, and to forget the narrowness of the experimental foundation upon which many of them rest.

By direct observation, one of the most experienced and successful experimenters of the last generation convinced himself that light of definite refrangibility was capable of further analysis by absorption. It has happened to myself, in the course of measurements of the absorbing power of various media for the different rays of the spectrum, to come across appearances at first sight strongly confirmatory of Brewster's views, and I can therefore understand the persistency with which he retained his opinion. But the possibility of further analysis of light of definite refrangibility (except by polarisation) is almost irreconcilable with the wave theory, which on the strongest grounds had been already accepted by most of Brewster's contemporaries; and in consequence his results, though urgently pressed, failed to convince the scientific world. Further experiment has fully justified this scepticism, and in the hands of Airy, Helmholtz, and others, has shown that the phenomena by which Brewster was misled can be explained by the unrecognised intrusion of diffused light. The anomalies disappear when sufficient precaution is taken that the refrangibility of the light observed shall really be definite.

On similar grounds undulationists early arrived at the conviction that physically light and invisible radiant heat are both vibrations of the same kind, differing merely in wave-length; but this view appears to have been accepted slowly, and almost reluctantly, by the experimental school.

When the facts which appear to conflict with theory are well defined and lend themselves easily to experiment and repetition, there ought to be no great delay in arriving at a judgment.

Either the theory is upset, or the observations, if not altogether faulty, are found susceptible of another interpretation. The difficulty is greatest when the necessary conditions are uncertain, and their fulfilment rare and uncontrollable. In many such cases an attitude of reserve, in expectation of further evidence, is the only wise one. Premature judgments err perhaps as much on one side as on the other. Certainly in the past many extraordinary observations have met with an excessive incredulity. I may instance the fire-balls which sometimes occur during violent thunderstorms. When the telephone was first invented, the early reports of its performances were discredited by many on quite insufficient grounds.

It would be interesting, but too difficult and delicate a task, to enumerate and examine the various important questions which remain still undecided from the opposition of direct and indirect evidence. Merely as illustrations I will mention one or two in which I happen to have been interested. It has been sought to remedy the inconvenience caused by excessive reveberation of sound in cathedrals and other large unfurnished buildings by stretching wires overhead from one wall to another. In some cases no difference has been perceived, but in others it is thought that advantage has been gained. From a theoretical point of view it is difficult to believe that the wires could be of service. It is known that the vibrations of a wire do not communicate themselves in any appreciable degree directly to the air, but require the intervention of a sounding-board, from which we may infer that vibrations in the air would not readily communicate themselves to stretched wires. It seems more likely that the advantage supposed to have been gained in a few cases is imaginary than that the wires should really have played the part attributed to them.

The other subject on which, though with diffidence, I should like to make a remark or two, is that of Prout's law, according to which the atomic weights of the elements, or at any rate of many of them, stand in simple relation to that of hydrogen. Some chemists have reprobated strongly the importation of *a priori* views into the consideration of the question, and maintain that the only numbers worthy of recognition are the immediate results of experiment. Others, more impressed by the argument that the close approximations to simple numbers cannot be merely fortuitous, and more alive to the inevitable imperfections of our measurements, consider that the experimental evidence against the simple numbers is of a very slender character, balanced, if not outweighed, by the *a priori* argument in favour of simplicity. The subject is eminently one for further experiment; and as it is now engaging the attention of chemists, we may look forward to the settlement of the question by the present generation. The time has perhaps come when a redetermination of the densities of the principal gases may be desirable—an undertaking for which I have made some preparations.

If there is any truth in the views that I have been endeavouring to impress, our meetings in this section are amply justified. If the progress of science demands the comparison of evidence drawn from different sources, and fully appreciated only by minds of different order, what may we not gain from the opportunities here given for public discussion, and, perhaps more valuable still, private interchange of opinion? Let us endeavour, one and all, to turn them to the best account.

SECTION B

CHEMICAL SCIENCE

Opening Address by Prof. G. D. Liveing, M.A., F.R.S., F.C.S., President of the Section

If I were asked in what direction chemical science had of late been making the most important advance, I should reply that it was in the attempt to place the dynamics of chemistry on a satisfactory basis, to render an account of the various phenomena of chemical action on the same mechanical principles as are acknowledged to be true in other branches of physics. I cannot say that chemistry can yet be reckoned amongst what are called the exact sciences, that the results of bringing together given matters under given circumstances can yet be deduced in more than a few special cases by mere mathematical processes from mechanical principles, but that some noteworthy advances have in recent years been made which seem to bring such a solution of chemical problems more nearly within our reach.

To show how large a gap in our ideas of chemical dynamics has been bridged over within the last quarter of a century, I will quote the words of one of the largest-minded philosophers of his time, who was one of the earliest promoters of this Association, and its President in 1841; Whewell, in a new and much altered edition of his "Philosophy of the Inductive Sciences," published in 1858, says:—"Since Newton's time the use of the word *attraction* as expressing the cause of the union of the chemical elements of bodies has been familiarly continued; and has no doubt been accompanied in the minds of many persons with an obscure notion that chemical attraction is in some way a kind of mechanical attraction of the particles of bodies. Yet the doctrine that *chemical* attraction and *mechanical* attraction are forces of the same kind, has never, so far as I am aware, been worked out into a system of chemical theory; nor even applied with any distinctness as an explanation of any particular chemical phenomena. Any such attempt, indeed, could only tend to bring more clearly into view the entire inadequacy of such a mode of explanation. For the leading phenomena of chemistry are all of such a nature that no mechanical combination can serve to express them without an immense accumulation of additional hypotheses." And further on he says:—"We must consider the power which produces chemical combination as a peculiar principle, a special relation of the elements, not rightly expressed in mechanical terms." (Hist. of Scientific Ideas, II., pp. 13, 14).

The influence by which our ideas have gone round so as to be now the very opposite of those of the illustrious thinker whom I have just quoted, so that we should ridicule the thought of looking for an explanation of chemical action on any but mechanical principles, is undoubtedly the progress which has been made in other branches of molecular physics. The indestructibility of matter has long been a formula familiar to chemists, but that the conservation of energy should be as universally true even in regard to chemical actions, has only in recent years been fully recognised. This is certainly no new principle, it was developed mathematically generations ago; but the realisation that it is anything more than abstraction, that it is the keynote of every rational explanation of physical phenomena, has been the foundation of recent progress in physical science; and if all energy be one, there can be but one code of dynamical laws which must apply to chemistry as well as all other branches of physics. The development of the mechanical theory of heat, and of the molecular theories which have grown up in consequence of it, have done much to set our minds free from preconceived notions, and to induce us to build chemical theories on something more than unverified conjectures.

But how far can we say that mechanical principles are actually recognised as the true basis of rational chemistry? So far as I know no chemist denies that it is so, and yet how little do our text-books, even the most recent and the most highly reputed, show the predominance of this idea! How very small a portion of such books is taken up with it; how much seems utterly to ignore it, or to be couched in language which is antagonistic to it! We still find chemical combinations described as if they were statical phenomena, and expressions used which imply that two perfectly elastic bodies can by their mutual action alone bring each other into fixed relative positions. We still find change of valency described as a suppression of "bonds of affinity," as if a suppression of forces were the usual course of nature, or as it it were possible that the same two forces, acting at the same place and in the same direction, should at one time neutralise one another, and at another time not neutralise one another. We still find saturated compounds spoken of, as if the stability of a compound were independent of circumstances, and chemical combination no function of temperature and pressure. Beginners are sometimes helped by the invention of intermediate reactions in explanation of final results, without any reference to the dynamical conditions of the problem, without any consideration whether the fancied intermediate reactions imply a winding up or a running down of energy. In fact our long familiar chemical equations represent only the conservation of matter and to keep always in mind the mechanical conditions of a reaction is as difficult to some of us as it is to think in a foreign language. Moreover we still find in many of our text-books the old statical notion of chemical combination stereotyped in pictures of molecules. I do not, of course, mean to accuse the distinguished inventors of graphic formulæ of meaning to depict molecules, for I believe that they would agree with me in thinking that these diagrams do not any more nearly represent actual molecules than they represent the solar system; but unfortunately we cannot prevent beginners from regarding them as pictures, and moulding their ideas upon them. They present something easily grasped by the infant mind, and schoolmasters are fond of them; but only those who have each year to combat a fresh crop of misconceptions and false mechanical notions engendered by them, can be aware how much they hinder, I won't say the advance, but the spread of real chemical science. If it be true that the illustrations of an artist like the late Hablot Browne give to our conceptions of the characters of a story a more definite and permanent, though perhaps a much modified form of what the author of the story intended to portray, it is equally true that the illustrations by which some, even great names among us, have tried to make us fancy that we had a true conception of some natural process have become so fixed in our minds, as to prevent our realising the true meaning of nature.

What, then, is the progress which I think has been made in physical chemistry? In the first place, notwithstanding the slowness with which new ideas replace old familiar images, the molecular theories developed by Clausius, Clerk-Maxwell, Boltzmann, and by Sir W. Thomson, have been long enough before the world to have greatly loosened the hold upon our minds of many old notions. The rigid, unbreakable, impenetrable atoms of the Epicurean philosophy made familiar to us by Lucretius always presented difficulties which were only perhaps exceeded by those of the elastic atmospheres with which modern philosophers fancied them to be surrounded; but now the vortex theory, whether we think it probable or not, at least gives us a standing ground for the assertion that the supposed impenetrability of matter and the curious compound of nucleus and atmosphere which has been invented to account for elasticity are not necessary assumptions. The kinetic theory of gases has analysed for us the different motions of the molecules in a mass of matter, and has facilitated the conception of the part which heat plays in chemical action. Hence we have had of late several attempts to reduce to a form susceptible of mathematical calculation the problems of chemistry. Most of these attempts have proceeded on the well-known mechanical principle that the change of *vis viva* of a system in passing from an initial to a final configuration is independent of the intermediate stages through which it may have passed so long as the external conditions are unaltered; and on the principle of the dissipation of energy, that is to say, on the condition that the state of the system, if it be a stable one, must be such that the energy run down in reaching it is a maximum. These principles have been applied successfully to the solution of some particular cases of the equilibrium between a mixture of chemicals by Willard Gibbs, Berthelot, and others. By the first-mentioned principle, all consideration of the intermediate stages by which the final result is reached are avoided. Quite recently Lemoinne has attacked the same problem on another principle. His principle is that of an equilibrium of antagonistic reactions in a mixture of materials, a mobile equilibrium such as we are now familiar with, dependent on compensating effects; but he does not seem able to solve the problem in any great number of cases. In fact, the difficulty does not now lie so much in expressing mathematically the conditions of the problem as in the defect of knowledge which depends upon experiment. And it is just in this that I think the outlook most hopeful. In some cases the patient work of weighing and measuring and comparing, which is necessary to make our theoretic speculations of any substantial value, has been already done for us. The publication, three years since, of Berthelot's essay on chemical mechanics has given us in a collected form a large quantity of data of the first importance; and now I am glad to say that the long labours of another worker in the same field, Thomsen of Copenhagen, are in course of publication in a handy form. I think these two investigators have done more than any one else of late years towards making it possible to give to chemistry the rank of an exact science. But besides the data which they have supplied to us, there are others which are yet wanting. For instance, almost every equation of chemical equilibrium involves an expression depending on the specific heats of the materials. At present we do not know enough of the law of specific heats to be able to give in most cases a probable value to those expressions; but these and other data of the kind do not seem out of our reach, and we may hope that the same ingenuity and patience which hss gained for us so much firm ground in thermal chemistry will extend it to the uncertain spots where we have yet no solid foundation.

Further, the laws of dissociation so ably investigated by Deville have taught us that the force called chemical affinity, by which we suppose the atoms of unlike matters are held together in a compound molecule, follows precisely the same laws as the force of cohesion, by which particles of a similar kind are united in molecules. We have long known that the molecules of sulphur vapour are broken up into simpler molecules by elevation of temperature, and condense again when the temperature is reduced. Other elementary substances behave in a similar way. We have within the last two or three years learnt that iodine is in part dissociated by a high temperature from molecules consisting of two chemical atoms into molecules consisting of only one such atom, and the same is true of chlorine and bromine. That some such change must occur in iodine and other metalloids was inferred as long ago as 1864 by the younger Mitscherlich. He argued that iodine is a compound body from the fact that it shows two spectra—one similar in character to those of metallic oxides, and the other similar to the spectra of metals; and from the analogy in the behaviour of iodine to a metallic oxide in giving the one spectrum at one temperature, and the other at a higher temperature, "from this it would follow that iodine at ordinary temperatures and iodine at the temperature of a hydrogen flame must be conceived as two different compounds, because the spectrum of iodine formed at ordinary temperatures" "*i.e.* the absorption spectrum of iodine vapour" "is different from that produced in a hydrogen flame. Also, "that bromine, though it gives no flame spectrum, gives one spectrum by absorption, and another by the electric spark, and must therefore in its ordinary state be regarded as a compound." Also that "the spectra formed by the flames of selenium, tellurium, and phosphorus, and those of sulphur and nitrogen given by feeble electric discharges, all have the character of the iodine flame spectrum, and these metalloids would therefore, if the above expressed supposition with regard to iodine be confirmed, also be compound bodies" (*Phil. Mag.*, 1864, p. 188). Since the paper from which the foregoing sentence is taken was published, not only the metalloids, but many metals have been found to give complicated spectra at one temperature, and much simpler spectra at higher temperatures. Such are the channelled spectra of sodium and potassium first described by Roscoe and Schuster, the channelled spectra of silver, bismuth, and other metals described by Lockyer and Roberts, and the ultra-violet channelled spectrum of tin recently photographed by Prof. Dewar and myself. But Mitscherlich's hypothesis gives us a rational explanation of such multiple spectra produced by the same substance, and it has been accepted in one form or another by all spectroscopists since he wrote.

Nevertheless, the existence of multiple spectra cannot be taken as a proof of allotropic modification, unless the possibility of a chemical combination is excluded. The channelled spectrum which magnesium gives in hydrogen was mistaken by more than one observer for that of some modification of the simple metal, until it was shown that magnesium in nitrogen and other gases does not give it, provided hydrogen be excluded, and that its persistence in hydrogen at high temperatures depends, as it should if due to a chemical combinations, on the pressure of the gas. If, however, homogeneous molecules are dissociated by heat, so also are heterogeneous molecules, formed as we say by chemical combination, split up by elevation of temperature, to unite again on cooling or by increase of pressure within certain limits. Nor is there any essential difference in character between a chemical compound and an element beyond that of facility of decomposition. If we could not so easily resolve them into their constituents, and were to disregard the characteristic differences of the spectra, no one would suppose ammonium to be constituted differently from potassium, or cyanogen from chlorine. Indeed, chemists have long been in the habit of considering the union of two atoms in a molecule of ordinary hydrogen or chlorine as a species of chemical combination, but when we find that the combinations of particles of the same kind are as definite as those of particles of different kinds, and that they are both subject to precisely the same mechanical laws, we are hardly justified in regarding the forces by which they are produced as essentially different. To get rid of a gratuitous hypothesis in chemistry must be a great gain.

But it may be asked why stop here? Why may not the chemical elements be further broken up by still higher temperatures? *A priori* and from analogy, such a supposition is extremely probable. The notion that there is but one elementary kind of matter is at least as old as Thales, and underlies Prout's hypothesis that the atomic weights of our elements are all multiples of that of hydrogen. This famous hypothesis has gone up and down in the scale of credibility many times during the present century. About seventeen years ago the publication of Stas' new determinations of combining numbers, carrried out on a scale never before attempted, and with all the refinements which the growth of our knowledge could suggest, was thought to have given it its deathblow. But a reaction has set in since that time. The periodic recurrence of the properties of elements with regular additions to the atomic weights, like octaves on a musical scale, put forcibly before us by Mendelejeff, makes it difficult not to think that there is a simple relation between the atomic weights, though there may be causes producing slight perturbations of such a relation. Quite recently a fresh revision of the combining weights has been made on the other side of the Atlantic by Prof. F. W. Clarke. He has collected all the determinations made by different observers, and after rejecting such as from defective methods were untrustworthy, has applied to the remainder such corrections as newer experiences have suggested, and then deduced from the corrected numbers the most probable values by the methods of the theory of errors. Prof. Clarke has done a piece of work of the highest utility, for which chemists must be grateful; nevertheless he has not carried the revision so far as it might be carried. He has, to begin with, rightly separated the several sets of observations, and deduced the most probable number for each set by itself, but in combining the various sets for the final determination of the numbers adopted, he has treated the results obtained by different methods as if they were a set of observations all presumably of equal value, so that the most probable numbers could be deduced by the method of least squares. He has not attempted any discussion of the different methods with a view to an estimate of the relative values of the results obtained by them, nor made any difference between the values of the figures deduced from operations on the large scale employed by Stas, and those arrived at on the small scales of other observers. Any sort of handicapping of methods is no doubt a very difficult and delicate operation, and requires more than the judgment of an Admiral Rous, but without it the question whether the numbers adopted are the best obtainable, will always be an open one. It is, however, a very noteworthy fact that in almost every case the numbers deduced from Stas' experiments taken by themselves, coincide very closely with the most probable numbers derived by the method of least squares from the whole of the recorded estimates. On the whole, Prof. Clarke concludes that Prout's hypothesis, as modified by Dumas, is still an open question; that is to say, his final numbers differ from whole multiples of a common unit by quantities which lie within the limits of errors of observation and experiment.

Let us turn again to the evidence afforded by our most powerful instrument for inspecting the inner constitution of matter, the spectroscope. A few years ago Mr. Lockyer supposed that the coincidence of rays emitted by different chemical elements, particularly when those rays were developed in the spark of a powerful induction-coil and in the high temperatures of the sun and stars, gave evidence of a common element in the composition of the metals which produced the coincident rays. Such an argument could not be drawn from the coincidences unless they were exact, and the identity of the lines could only be tested by means of spectroscopes of great resolving power. By the use of the well-known Rutherford gratings, Young, in America, had found that most of the solar lines which had been ascribed to two metals were in reality double, and Prof. Dewar and I, working on the terrestrial elements in the electric arc, had found the actual coincidences to be very few indeed. These observations, even with a Rutherford grating, were delicate enough; but quite recently M. Fievez, of the Brussels Observatory, has brought to bear on this question a spectroscope of unexampled power. By combining two of the Astronomer-Royal's highly-dispersive half-prisms with a Rutherford grating of 17,296 lines to the inch, he has obtained a dispersion quadruple that of Thollon's combination of prisms. Bringing this to bear on the sun, he has mapped the solar spectrum from a little below C to somewhere above F on a scale one-third greater than that of Vogel's map, and has not only confirmed the work of Young, Dewar, and myself, but has resolved some lines which were not divisible with such dispersive power as we had at command. This result cannot fail to shake our belief, if we have any, in the existence of any common constituent of the chemical elements; but it does not touch the evidence which the spectroscope affords us that many of our elements in the state in which we know them must have a very complex molecular structure. I cannot illustrate this point better than by the spectra of two of our commonest elements, magnesium and iron. We have good reason to think the molecule of magnesium to be as simple as that of any of our elements, and its spectrum is one of the simplest, consisting of a series of triplets which repeat each other in a regular way and are probably harmonically related, and of a comparatively small number of single lines, of which also some may be harmonics. The spectrum of iron, on the other hand, presents thousands of lines distributed irregularly through the whole length, not only of the visible, but of the ultra-violet region. Make what allowance you please for unknown harmonic relations and for lines not reversible, which may not be directly due to vibrations of the molecules, we still have a number of vibrations so immense that we can hardly conceive any single molecule capable of all of them, and are almost driven to suppose them to be due to a mixture of differing molecules, though as yet we have no independent evidence of this, and no satisfactory proof that any of this mixture is of the same kind as occurs in other elements.

M. Fievez's combination is a great advance in resolving power, but Prof. Rowland, of the Johns Hopkins University, promises us gratings not only exceeding Rutherford's, both in dimensions and accuracy of ruling, but ruled upon curved surfaces, so as to dispense with the use of telescopes and avoid all variations of focussing the different orders of spectra. His instruments, if they come up to the promise he holds out, will enable us to solve many questions which are difficult to answer with our present appliances.

But to return to the chemical elements: the spectroscope has in the last few years revealed to us several new metals. I will not venture to say how many; for when several new metals more or less closely allied are discovered at the same time, the process of sifting out their differences is necessarily a slow one. We cannot tell yet whether any of them are to fill gaps in Mendelejeff's table, and so add strength to the conviction that there is a natural relation between the atomic weights and the chemical characters of our elementary substances; or whether they will add to the embarrassment in which we already find ourselves with regard to the relations of the cerium group of metals; whether we may welcome them as the supporters of order, or deprecate their coming as authors of confusion. Granting that the chemical characters of an element are connected with its atomic weight, we have, however, no right to assume them to be dependent on that factor alone. Why may there not be elements which, while they differ as little in atomic weight as do nickel and cobalt, are, on the other hand, so similar to one another in all characters, that their chemical separation may be a matter of the greatest difficulty, and their difference only distinguishable by the spectroscope? The spectra may be thought to suggest so much, and how shall we decide the question? At any rate the complications of the spectroscopic problem are such as can only be unravelled by the united efforts of chemists and physicists, and by the exercise of extreme caution.

I cannot dismiss the subject of chemical dynamics without alluding to the ingenious theory by which the President of the Association has proposed to account for the conservation of solar energy. He supposes planetary space to be pervaded by an atmosphere which, except where it is condensed by the attraction of the sun and planets, is in a highly attenuated state. The sun and planets communicate some of their own motion of rotation to the atmosphere condensed about them, and he supposes that in this way an action like that of a blowing fan is set up, by which the equatoreal part of the sun's atmosphere acquires such a velocity as to stream out to distances beyond the earth's orbit, while an equal quantity of gas is drawn in at the poles to maintain equilibrium. The gases thus driven to a distance in planetary space will of course be enormously expanded and highly attenuated, and in this state Dr. Siemens thinks that such of them as are compound may be decomposed by absorbing the solar radiation, and thus the kinetic energy of solar radiation be converted into the potential energy of chemical separation. The separated elements or partial compounds will, in the circulation produced by the fanlike action of the solar rotation, be carried back to the polar regions of the sun as fuel to maintain his temperature by condensation and re-combination. I will not discuss the mechanical part of this theory farther than to remark that the fan-like action can only be carried on at the expense of the energy of the sun's rotation, which must be in consequence continually diminishing, and must in time become too slow to produce any sensible projection of the atmosphere into distant regions of planetary space. As to the chemical side of the theory, Dr. Siemens supposes the gases which pervade the planetary space to be not only of the same kind as the components of our own atmosphere, which, on the kinetic theory of gases diffuse through that space, but also such gases as are not found in our air, but are found occluded in meteorites which may be supposed to have acquired them in their previous wanderings. Amongst these he specially mentions hydrocarbons which form the self-luminous part of most comets. It is to these gases, together with aqueous vapour, and carbonic acid, that he ascribes the principal part in the conservation of solar energy. That compound gases at the extremely low pressure of the planetary space are decomposed by solar radiation is not inconsistent with the laws of dissociation, for it is quite possible that some compounds may be decomposed at ordinary temperatures by mere reduction of pressure, and the radiation absorbed will be the more effective, because it will directly affect the vibratory motion within the molecule, and may well produce chemical decomposition before it can, when the free path of the molecules is so much increased by the attenuation of the gas, assume the form of an increased temperature. Dr. Siemens, moreover, adduces a remarkable experiment in confirmation of his supposition. We know, too, the power which our atmosphere, and especially the water vapour in it, has of absorbing the infra-red rays, and that amongst the Fraunhofer lines some of the strongest groups are due to aqueous vapour, and the capital observation made by the spectroscopic observers at the last total eclipse, that the group of lines known as "B," which is one of those produced by aqueous vapour, is greatly strengthened when the sun's light passes by the edge of the moon and so through the lunar atmosphere, may be taken as a confirmation of the theory that gases, like our atmosphere, are diffused through space and concentrated about the planets. But if it be true that the compounds are decomposed by absorbing the sun's rays, we ought to find in our atmosphere the products of decomposition, we ought to find in it free hydrogen, carbonic oxide, and acetylene or some other hydrocarbons. The hydrogen from its small specific gravity would not be concentrated in the lower regions of our atmosphere in the same proportion as the denser gases, but carbonic oxide and hydrocarbons could not fail to be detected in the air if they formed any sensible proportion of the gases in the planetary space. That a large portion of the solar radiation is intercepted before it reaches the earth, is no doubt true, for there are not only the dark bands which are increased by our atmosphere, and may reasonably be attributed in part to the action of like gases pervading the space between us and the sun, but there is a continuous absorption of the ultra-violet spectrum beyond the line U, and Cornu has found that this absorption is not sensibly affected by our atmosphere, so that the substance, whatever it may be which produces it, may be an agent in the process imagined by Dr. Siemens, but cannot be the means of restoring to the sun any portion of the radiant energy which reaches our distance from him.

Dr. Siemens explains the self-luminous character of comets by the theory that the streams of meteoric stones, of which they are supposed to consist, bring from stellar space hydrocarbon and other gases occluded within them; and that in consequence of the rise of temperature due to the frictional resistance of such a divided mass moving with enormous velocity, aided by attractive condensation, the occluded gases will be driven out and burnt, the flame giving rise to the original light emitted by the nucleus. Now the spectrum of most comets shows only the principal bands of a Bunsen burner, and is therefore adequately explained by the flame of gas containing hydrocarbons, such as have been found in meteorites. But Dr. Huggins has observed in the spectrum of more than one comet not only hydrocarbon, but cyanogen bands, and, although carbon and nitrogen combine readily in the electric arc, a coal gas flame in air shows no trace of the spectrum of cyanogen, and it would certainly put some strain on our credulity if it were asserted that cyanogen were one of the gases brought ready-formed by meteorites from stellar space. Prof. Dewar and I have, however, recently shown that if nitrogen already in combination, as, for instance, in ammonia, be brought into a hydrocarbon flame, cyanogen is produced in sufficient amount to give in a photograph (but not so as to be directly visible) the characteristic spectrum of cyanogen as it appears in the comets. It is therefore no longer necessary to make any other supposition to account for the cyanogen bands in the spectra of comets than that ammonia or some such compound of nitrogen is present, as well as hydrocarbons in a state of ignition.

Quite recently Dr. Huggins has observed that the principal comet of this year has a spectrum of an entirely different character, but he is not yet able to say to what elements or compounds it is probably due. The notion that comets may bring us news of distant parts of stellar space, towards which our system is driving, where the atmosphere is not like ours, oxygen and nitrogen, but hydrogen and hydrocarbons, may fascinate the fancy, but the laws of occlusion oblige us to think that the meteorites have not merely wandered through an attenuated atmosphere of hydrogen and hydrocarbons, but have cooled in a much denser atmosphere of these substances, which we can only conceive as concentrated by the presence of a star or some large aggregation of matter. They may perchance have come from some nebulous mass, for Draper and Huggins tell us that in the great nebula in Orion, hydrogen is dense enough and hot enough to show some of its characteristic lines, besides the F line, which is seen in other nebulæ, and is the last to disappear by reduction of density. No comet on visiting our system a second time can repeat the exclusion of its occluded gases unless its store has been replenished in the interval, and it will be interesting to see when Halley's comet next returns, whether it shines only by reflected light, or gives us, like so many others, the banded spectrum of hydrocarbons.

SECTION D

BIOLOGY

OPENING ADDRESS BY ARTHUR GAMGEE, M.D., F.R.S., BRACKENBURY PROFESSOR OF PHYSIOLOGY IN OWENS COLLEGE, MANCHESTER, PRESIDENT OF THE SECTION.

On the Growth of our Knowledge of the Function of Secretion, to which is prefixed a Brief Sketch of the Writings of the late Professor Francis Maitland Balfour.—When the Council of the British Association did me the honour of asking me to preside over this section, it occurred to me that a suitable subject for the presidential address would be a Survey of the Growth of our Knowledge of the Function of Secretion; for no subject, which has recently been the object of minute study by animal physiologists, is more likely to interest all devoted to biological pursuits, however diverse. I accordingly propose to direct your attention, for the greater part of the time at our disposal to-day, to what appears to me to be the most important and the most interesting of the researches bearing on this subject.

Before, however, entering upon the proper subject of this address, it would ill become me as president of this section were I not to speak to you, however imperfectly, of two great losses which we have sustained, and which have saddened, and still sadden, the hearts of many of us. The year 1882 will long be memorable, and sadly memorable, as a year during which English biology sustained irreparable losses. So much has lately been written concerning that veteran in science, Charles Darwin, who will figure in the history of the human intellect with such men as Socrates and Newton, that I feel no words of mine are needed to add to your sentiments of admiration and respect. He has made for himself an imperishable reputation as one of the subtlest, most patient, and most truthful observers of natural phenomena. His powers as an observer were, however, almost surpassed by his ingenuity as a reasoner, and his power to frame the hypotheses most apt, in the actual state of science, to reconcile all the facts which came within the range of his observation. We remember the time when the name of Charles Darwin, and the mention of the theories connected with his name, awakened, on the part of many, sentiments of antagonism and of unreasonable opposition. But we have lived to witness, what I may term, a great reparation. Even those who did not know the man, and the qualities of mind and heart which endeared him to so many, have come to recognise that in his work he was actuated by a single-hearted desire to discover the truth; and, after calm reflection, they have conceded that his studies and his views like all studies and all views which are based upon the truth, not only are not irreconcilable with, but add to our conceptions of, the dignity and glory of God. And here I may be allowed to remark that it is impossible to study the writings of Darwin, and especially the one in which he treats of "The Descent of Man," without recognising an undercurrent of reverent sentiment, which in one or two places finds expression in words telling us that man differs from the animal creation, if not in physical characteristics which cannot be bridged over, at least in moral attributes and in the "ennobling belief in God," by his power of forming that conception of the Deity which, to use Darwin's own words, is, "the grand idea of God hating sin and loving righteousness." ("The Descent of Man and Selection in Relation to Sex." Second edition (1874), page 144.)

We cannot help mourning for our great ones, though they be taken from us in the fulness of years, and when their labours have been so numerous and so productive that we marvel that they have been able to achieve so much within the span of a single life; but our grief is immeasurably greater when the man of genius is taken from us in the plentitude of strength, as it were upon the threshold of a life full of extraordinary promise.

Francis Maitland Balfour, whose sudden death has so recently cast a gloom over us all, was a man who appeared destined to advance our knowledge of animal development more than it had been advanced by the labours of any one of his predecessors. His death recalls the train of thought which we have pursued when reflecting upon the lives and works of such men as Mayow and Bichat, Gerhardt and Clifford. If so much could be achieved in so short a life, what great benefits would science not have derived, what remarkable steps in advance might not have been made, had it been given to these great minds to work on for the good of their race during a lifetime of ordinary length. It must be sufficient for us that it was destined otherwise; and, in mourning for our departed friend, we may at least reflect that we would not have him less worthy of our admiration in order that we might mourn him the less.

THE RESEARCHES OF FRANCIS MAITLAND BALFOUR.

At the risk of having to be somewhat brief in my discussion of the subject proper of this address, I must yield to the impulse which leads me to give you some account of Balfour's work.[1]

Having been educated at Harrow, Balfour entered Trinity College, Cambridge, in the year 1870. His friend and master, Michael Foster has told us how, from the very first, besides engaging in systematic studies which he was able to pursue with no small degree of success, he devoted himself with passion to original research. At the very outset Balfour engaged in work which led to speculations of a fundamental and far-seeking nature, and of the three embryological papers, (*Studies from the Cambridge Physiological Laboratory*. Part I., 1873. *Quarterly Journal of Microsopical Science*, vol. xiii., 1873.) which he wrote before taking his degree, two related to questions which occupied his attention in a special manner to the end. One of these, "On the Development and Growth of the Layers of the Blastoderm," contains several statements not afterwards maintained; for instance, as to the independent origin of the mesoblast in the chick, where it is said "neither to originate from the epiblast nor from the hypoblast, but to be formed coincidentally with the latter, out of apparently similar segmentation cells." The other, "On the Disappearance of the Primitive Groove in the Chick," calls attention to, and corroborates Dursy's discovery of seven years before, and closes with a suggestion of the great hypothesis (afterwards elaborated) that the primitive streak is a lingering remnant of the blastopore. Balfour also wrote whilst an undergraduate "On the Development of the Blood-vessels in the Chick," but it may be doubted whether he advanced our knowledge of this obscure subject.

The "Elements of Embryology," by Michael Foster and Balfour, appeared (1874) shortly after Balfour had taken his degree (1873), and Foster has generously recorded how great was the part his pupil took in the production of this book. The month after taking his degree he made his first journey to Naples, and it was whilst working there that he entered upon his remarkable investigation on the development of Elasmobranchs. The natural outcome of Gegenbauer's exposition (Gegenbauer, "Das Kopfskelett der Selachier," 1872) of the primitive character of this group was that increased interest should attach to all researches on its embryology. To an introductory account of the embryology of Elasmobranchs (*Quarterly Journal of Microscopical Science*, vol. xiv., 1874.) Balfour owed, I believe, his fellowship at Trinity College, and from that time onwards until 1878 he pursued the investigation at Naples and in Cambridge. The collected results appeared in 1878, as "A Monograph on the Development of Elasmobranch Fishes." No research upon a limited group ever contained more numerous or more wide generalisations, extending over the whole domain of vertebrate embryology. I may dwell for a few moments upon some of its most interesting sections.

The structures which we are now familiar with as "head-cavities" are described for the first time, and named; their relation to the cranial nerves and their resemblance or equivalence to the muscle plates of the body are pointed out; and Balfour seizes upon their value in throwing light upon the great problems of the segmentation of the head and the segmental value of the cranial nerves. In particular the 5th nerve and the 7th, with the auditory, are specified as the segmental nerves of the mandibular and hyoid segments. The short, but very important, notice of the sympathetic system showed that its ganglia developed on branches of the spinal nerve, and that it was therefore a product of the epiblast ("Elasmobranch Fishes," p. 172.) The primitive features of the mesoblast and notocord and their hypoblastic origin are described, ("Elasmobranch Fishes," pp. 49, 85, 92, 104.) and furnish material for the comparison afterwards instituted in the "Comparative Embryology" (vol. ii., pp. 243, 246.) between their development in Elasmobranchs and their still more primitive origin in Amphioxus, as diverticula of the archenteron. A very able chapter on excretory organs concludes this monograph. This subject had engaged Balfour's attention very early, and his introductory account of Elasmobranch Development contains his discovery of segmental organs in Elasmobranchs,—a discovery made independently but simultaneously by Professor Semper. These organs are shown to develop in the mesoblast, and are compared with the segmental organs of annelids.

A paper published in 1876 gives a singularly clear and thorough *résumé* of our knowledge of the development of the urino-genital system; and the diagrams there given, illustrating the homologies of the male and female urino-genital organs, are wonderfully simple and instructive. Shortly after the publication of this paper, Balfour became a Fellow of the Royal Society, for which he received a Royal Medal in 1881.

Among the interesting points that Balfour had made clear in connection with the spinal nerves of Elasmobranchs, was the fact that the anterior and posterior roots arise alternately, and not in the same vertical plane. He sought for an explanation of this in Amphioxus at Naples, in 1876. Owsjannikow and Stieda had discovered that the nerves of the opposite sides in Amphioxus arise alternately, and Stieda further stated that the nerves of the *same* side arise alternately from the dorsal and ventral corners of the cord. Stieda considered that two adjacent nerves were together equivalent to a single spinal nerve of higher vertebrates. Balfour (*Journal of Anatomy and Physiology*, vol. x., 1876.) found no trace of difference of level in the origin of nerves on the same side, *i.e.* he denied the existence of ventral or anterior roots; and afterwards, in investigating the cranial nerves of higher vertebrates, and being unable to find any trace of anterior roots, he framed the bold hypothesis ("Elasmobranch Fishes," p. 193, "Comparative Embryology," vol. ii., p. 380.) that the head and trunk had been differentiated from each other at a time when mixed motor and sensory posterior roots were the only roots present, and that cranial and spinal nerves had been independently evolved from a common ground-plan.

Balfour's investigation of the development of the ovary was incomplete when his work on Elasmobranchs appeared; and he continued to work at this subject, both in Elasmobranchs and Mammals, publishing upon it in 1878 (*Quarterly Journal of Microscopical Science*, vol. xviii., 1878.) A paper published in the same year, on the "Maturation and Impregnation of the Ovum," contained the very ingenious suggestion that the casting out of the polar bodies prevents the ovum developing by itself into a new individual, *i.e.* prevents parthenogenesis; and Balfour points out that parthenogenesis is practically confined to the arthropoda and rotifera, which are the only two groups in which polar bodies are not known to occur.

Balfour still continued, now in conjunction with Sedgwick, his researches on the urino-genital system, and described, among many other new points, the existence of a head-kidney (pronephros) in the chick (*Proceedings* of the Royal Society, vol. xxvii., 1878).

In this year, Balfour also investigated (*Quarterly Journal of Microscopical Science*, vol. xix., 1879.) the early development of Lacerta, and pointed out the presence of a primitive streak and of a neurenteric canal. This investigation confirmed his belief

---

[1] In the preparation of this part of my address I have been very greatly aided by one of Balfour's pupils, my nephew, D'Arcy W. Thompson, Scholar of Trinity College.

in the hypothesis previously quoted that the primitive streak is the relic of a blastopore.

At this time Balfour was working hard at his text-book of "Comparative Embryology." His published papers were no less numerous than before, but consisted in part of extracts from the more speculative chapters of the forthcoming book. He, however, published a paper, (*Quarterly Journal of Microscopical Science*, vol. xx., 1880.) containing the results of work scattered over two years, on the development of Spiders. He also published a paper (*Proceedings* of the Zoological Society, 1881.) on the skeleton of the paired fins, based upon his work on Elasmobranchs. In this he contests the views of Gegenbauer and Huxley, that the primitive fin consists of a central multi-segmented axis with many lateral rays, and is most nearly retained in Ceratodus; he rather considers the primitive form to be a longitudinal bar running along the base of the fin (basipterygium), and giving off at right angles a series of rays which pass into the fin. He adheres to the view expressed in the "Elasmobranch Fishes," (p. 101.) that the vertebrate limbs are remnants of two continuous lateral fins.

Another important paper of the same year dealt with the placenta. Balfour supposed that in the primitive Placentalia, simple fœtal villi, like those of the pig, projected from the discoidal allantoic region of the chorion into uterine crypts. The deciduate discoidal placenta of Rodents and Insectivores is the first stage in advance of this primitive type. Then along different lines diverge the zonary placenta of Carnivora, and the diffuse placenta of Suidæ, Lemuridæ, &c.; and the latter becomes contracted down to the discoidal placenta of man, a form in no way to be confounded with the primitive discoidal placenta of Rodents.

He engaged also, in conjunction with Mr. W. N. Parker, in a very important research; to be published in full in the "Philosophical Transactions," on the "Structure and Development of Lepidosteus." This paper contains an immense amount of new matter, both anatomically and embryological, and shows that Lepidosteus, though a true ganoid, has very marked teleostean affinities.

Balfour's last published paper, (*Quarterly Journal of Microscopical Science*, vol. xxii., 1882.) which appeared during his recent illness, was written with the assistance of Mr. Deighton, and related to the germinal layers of the chick. This paper describes, in a very beautiful way, the double origin of the mesoblast, partly from an axial strip of epiblast in the line of the primitive streak, and partly as two lateral plates differentiated from the hypoblast in front of the primitive streak.

Before his last, fatal journey, Mr. Balfour was engaged in preparing a new edition of the "Elements of Embryology," and in producing a very elaborate memoir on the "Anatomy and Development of Peripatus." He had previously investigated that animal, in 1879, and had cleared up the matter of its segemental organs (overlooked by Moseley), and demonstrated the presence of ganglia on its ventral nerve-cords.

Mr. Balfour became a member of this Association in 1871, the year after he entered Trinity College. At the brilliant Belfast meeting in 1874 he read his first paper before the Association on Elasmobranch Fishes; and this paper and Balfour's share in the keen discussion which followed are still remembered with admiration by many. In 1880, at Swansea, he delivered an address, as Chairman of the sub-section of Anatomy and Physiology, dealing with the mutual services rendered by the evolution theory to embryology, and by embryology to the evolution theory, with special reference to the developmental history of the nervous system. In 1881, he was appointed one of the two General Secretaries.

But the great text-book of comparative embryology ("Comparative Embryology," vol. i., 1880, vol. ii. 1881) is the real monument of Balfour's fame. It is impossible to convey an idea of the merits of this book. It grappled with the enormous mass of scattered literature upon the subject, and formed it all into a consecutive account, clear and accurate. Discordant statements were weighed and estimated, frequently brought into harmony by an ingenious explanation or by a new and crucial observation. Countless investigations were repeated and verified, and countless suggestions of important work, that still remains to be done, make the book as valuable to the *savant* as to the student. Among the chapters ("Comparative Embryology," vol. ii., chap. xi. xii. xiii.) most remarkable for broad and philosophic generalisations are those dealing with the "Ancestral Form of the Chordata," "Larval Forms," and the "Origin and Homologies of the Germinal Layers." Balfour accepts the gastrula as a stage in the evolution of the metazoa, and leans somewhat to invagination, as the more primitive process than delamination in the production of the gastrula. He shows distinctly that the mesoblast arose in the first instance, not independently, but as a differentation from the other two layers, and that the mesoblast is a homologous structure throughout the triploblastic metazoa. In the chapter on "Larval Forms" he gives numerous reasons and arguments for a larval development repeating the ancestral history, better and more fully than a fœtal development; he reviews the types of larvæ (discriminating six types), the cases tending to produce secondary changes in larvæ, and suggests, as a hypothesis for the passage from the radial to the bilateral type, that in a pilidium-ilke larva the oral face elongated unequally, an anterior part forming a præ-oral lobe, and a posterior outgrowth the trunk, while the aboral surface became the dorsal surface. He suggests that adult Echinodermata have retained, and not secondarily acquired, their radial symmetry, and considers a radially symmetrical organism, like a medusa, as the prototype of all the larval forms above the cœlenterates. Balfour does not admit the specially close relationship of the Chordata with the Chætopods, which Dohrn and Semper maintain; but considers that the Chordata descended from a stock of segmented worms derived from the same unsegmented types as the Chætopods, but in which two lateral nerve-cords like those of the nemertines coalesced dorsally instead of ventrally. He considers that the mouth in ancestral Chordata was suctorial, and was not formed, as Dohrn supposes, by the coalescence of two visceral clefts. Finally, Balfour draws up a scheme of the phylogeny of the Chordata, according to which the hypothetical protochordata, with a notochord with a suctorial mouth and very numerous gill-slits, acquired one by one, vertebræ, jaws, an air-bladder, a pentadactyl limb, an amnion: each new accession characterising a hypothetical protogroup, from which some existing group is supposed to have diverged.

Those of my hearers who had not followed Balfour, scientific labours, but who merely knew him as one of the most respected workers in the field of biology, will I trust, even from my brief sketch, have formed some idea of the activity and originality of his mind, and will understand how his death has occasioned a feeling almost akin to despair, in that he occupied a place which it appears to us now impossible to fill. "How are the mighty fallen, and the weapons of war perished!"

ON THE GROWTH OF OUR KNOWLEDGE OF THE PROCESS OF SECRETION IN THE ANIMAL KINGDOM.

The Views of the Ancients.—It was known to the ancients that organs of the body exist which are concerned in the separation from it of excrementitious substances, although the greatest doubts prevailed as to the organs to which such functions should be ascribed. Thus we find Hippocrates defining it as characteristic of glands that they occur in moist parts of the body; but showing his ignorance of the true relations of glands to secretion by connecting them with the formation of hairs, and discussing the question which we find our own Wharton debating again in the seventeenth century, and which he formulates, "Num cerebrum ad glandularum numerum vel viscerum accedat." The general opinion of the ancients, and the opinion which was adopted and by Galen, was that the glands were sieves or collanders (cola), which served to strain off from the blood purely excrementitious substances. The liver and kidneys were strangely enough removed from the group of glands and placed amongst the viscera. The first writer who appears systematically to have treated of the glands was the before-mentioned Wharton in his "Adenographia sive glandularum totius corporis descriptio." Although this author certainly added to the existing knowledge of the descriptive anatony of secreting organs, his views on the functions of glands were strangely fanciful and erroneous.

The glands he considered to be especially related to the nervous system, the viscera, so-called, to the blood-vessels; such glands as the pancreas, and the salivary and lachrymal glands being engaged in separating excrementitious substances from the nervous system. It was in 1665 that the great anatomist Malpighi ("Exercitatio Anatomica de Renibus") first attempted to investigate the structure of glands in a truly scientific spirit, endeavouring to establish a relationship between simple glandular follicles and such complex glands as the liver. All glands he believed to contain as ultimate elements bodies which he termed "*acini,*" a word which in its primitive classical sense has been used to designate the stone or seed of the grape or the grape itself. The conception, indeed, which Malpighi formed of an "*acinus*" was rather that of a secreting nodule than of an ultimate saccular or tubular recess. The "*acini,*" however, he believed to be in communication with the efferent ducts of the glands to which they belonged, and through which they poured out their proper secretion, derived in the first instance from the blood contained in minute arteries supplied to the gland. Ruysch (1696), known as the first celebrated injector of blood-vessels, finding that frequently the fluids which he forced into the blood-vessels of glands escaped through their ducts, or made their way into the surrounding tissues, concluded that the blood-vessels communicated directly with the interior of the glands; these he held to be organs which, according to the views that had long prevailed, merely strained off from the blood certain of its more liquid constituents. The views entertained by the most eminent of the supporters of Ruysch, the illustrious Haller were expressed by him as follows. After defining the term "acinus" to signify the ultimate division of a gland, he remarks that "the acini consists of congeries of vessels, bound firmly together with the cellular web, containing an excretory duct in their interior, which commences from the most minute arteries by small ducts impervious to the blood. . . . So that secretion differs from the ordinary circulations of the blood in this particular, that the smallest arteries are continuous with veins of equal or greater size, capable therefore of receiving the blood, whilst the excretory ducts are much smaller, in order to effect the separation of the secretion." (Haller, p. 275.) The advocates of the Ruyschian theory were compelled to have recourse to the most improbable hypotheses to explain the diversity of the secretions of different glands, as, for example, that different glands secrete different liquids, because of the difference in the diameters of the pores by which the blood-vessels communicate with the glands; that the different arrangement of blood-vessels, the mode in which they divide, the resistance which they offer to the flow of blood through them, by modifying the pressure and velocity of the blood-flow through the organ, induce secretions varying in character. It is strange to learn from Haller, as was indubitably the fact, that the great majority of his contemporaries, such men as Peyer and Vieussens, and even Boerhaave, adopted the Ruyschian view of the structure of glands. The opposition to Ruysch came first from Ferrein (Ferrein, "Sur la Structure des Glands," &c., *Mémoires de l'Acad. Roy. des Sciences de Paris*, 1749), who maintained that the kidneys essentially consist of an assemblage of convoluted tubes, which he looked upon to be the seat of the renal secretion—tubes which a subsequent investigator, Schumlansky (Schumlansky, "Dissertatio Inaugur. Anatomica de Renum structurâ, A gentoreti, 1880), looked udon as taking their origin in the *acini* of Malpighi, to which he referred the active part in secretion. Then followed the researches of Mascagni and Cruickshank, who found, by injecting quicksilver into the mammary glands, that the ramification of the ducts of this organ terminate in racemose follicles; though Mascagni still admitted a connection, by means of open pores, between the sides of the glandular blood-vessels and the interior of the glands themselves. It was unquestionably Professor E. H. Weber, of Leipzig, who completely demolished the Ruschyian hypothesis, and who by numerous researches on the salivary glands of birds and of mammals, and on the pancreas of birds, established the general fact of the termination of gland ducts in blind extremities, though with modesty he put forward his opinions as confirming the inductions of Malpighi, expressing himself as follows: "Admirably did Malpighi avail himself of the structure of the liver in the lower animals, and to the embryo of the higher, as a foundation-stone for his opinions; for the arrangement of the whole glandular system speaks for itself, inasmuch as it simply consists of single, compact, hollow, blind canals, more or less numerous, floating in the fluid which surrounds their organs; and, although these ramifications are drawn out between the branches of the blood-vessels, there is no immediate passage from one to the other."

The Researches of Johannes Müller.

Such was the state of knowledge in reference to the structure of secreting glands and secretion at the time when the great Johannes Müller undertook the investigation of which the results were first of all published in the memorable work entitled "De Glandularum secernentium Structurâ penitiori earumque prima Formatione" (Lips. 1830). It is impossible not to sympathise with the reflection of Professor Heidenhain, recently made in reviewing the researches of Johannes Müller in connection with this subject (Heidendain in Hermann's "Handbuch der Physiologie," vol. v., 1880, p. 6.), to wit, that the physiologists of to-day may be accused of ingratitude for having allowed the great name of Johannes Müller to have well-nigh disappeared from the pages of physiological literature. We forget that this man—this giant in the field of biology as he is appropriately termed by Heidenhain, the last man of whom perhaps it will ever be said that he was at once the greatest comparative anatomist of his time and the most philosophical and original of all contemporary physiological writers—by his own researches, and particularly by the one which concerns us to-day, influenced the progress of physiology, at a most critical period, more than any other man. He was not, like his contemporaries Magendie and Flourens, a great physiological experimenter, though he showed that he well appreciated the value of experiment in advancing our science; but he was pre-eminently a physiologist who recognised the immense importance of a close study of structure, not only because of the interest which it presents to the pure and philosophical morphologist, but because of its absolute necessity, if we are to penetrate at all deeply into the secrets of animal function. Müller, in the first instance, had convinced himself, by the study of the circulation of organs sufficiently transparent to permit of it, especially the circulation through the liver of larval salamanders, that, in glands, arteries never end in any other mode than by capillaries leading into veins. He then set himself to study in the case of most glands, and in a large variety of animals, the relationship of gland ducts to the truly secreting parts of the organ, and the relation of the blood-vessels to these. Basing himself upon these anatomical studies of adult organs, and upon a careful study of the development of glands—a study which had been attempted slightly by Malpighi, and more satisfactorily in the case of the parotid by E. H. Weber (E. H. Weber, "Beobachtungen über die Structur einiger conglomerirten und einfachen Drüsen und ihre erste Entwickelung." Mickel's *Archiv* for 1827, p. 274)—Müller came to the conclusion that all glands possessed of a duct are only involutions more or less complex of membranes, the largest number being involutions of the external investment of the body or of the membranes opening upon its surface. The following are the general results relative to the structure of glands which Müller deduced from the anatomical study of individual organs:—[1]

1. However various the forms of their elementary parts, all secreting glands without exception (not only those of the human body, but all met with in the animal kingdom) follow the same law of conformation, and constitute an uninterrupted series from the simplest follicle to the most complex gland.

2. No line of demarcation can be drawn between the secreting organs of invertebrata and those of vertebrate animals; not merely do we meet with the simplest sacs and tubular secreting organs, like those of insects, in the higher animals, but there is a gradual transition from these simple secreting organs to the glands of the most perfect vertebrata.

3. All glands agree in affording by their interior a large surface for secretion. The varieties of internal surface by which the great end—extent of surface in a small space—is attained, are very numerous.

4. *Acini*, in the hypothetical sense in which the term has been used by writers—in the sense viz. of secreting granules—do not really exist; there are no glomeruli of blood-vessels with ducts arising from them in a mysterious way, as has been supposed, whatever notions may have been held regarding them.

5. The parts described as *acini* are merely masses formed by the agglomeration of the extremities of the secreting canals; frequently, indeed, they are formed of minute vesicles aggregated together in grape-like bunches, which may be injected with mercury, and are often susceptible of inflation.

6. In many glands which have been incorrectly described to have *acini* or secreting granules, there are not even the hollow vesicular *acini*; the secreting tubes, instead of terminating in vesicles or cells, form long convoluted canals or straight tubuli or short cæca.

7. It has been demonstrated in the case of all glands that the blood-vessels are not continuous with the secreting tubes—that the minute vessels bear the same relation to the coats of the hollow secreting canals, and their closed extremities, as to any

---

[1] This abstract of Müller's general conclusions has been abbreviated from the sections treating on this subject in his "Elements of Physiology." See Translation by Dr. Baly, London, 1138, vol. i. p. 456, *et seq.*

other delicate secreting membrane, such as, for example, the mucous membrane of pulmonary air cells.

8. The arborescent ramification of the blood-vessels accompany the ducts in their development, and the reticulated capillaries in which the blood-vessels terminate are extended over all the closed elementary parts of the gland and supply them with blood. In the chick we may observe the simultaneous development of the two systems; in proportion as the development of internal surface from a plain membrane to cæcum and ramified cæca proceeds, the vascular layer of the originally simple membrane is raised on the exterior of the efflorescence.

9. The ramified canals and tubes, which when the structure is simple, as in insects and crustacea, and even in some glands of the mammalia, lie free and unconnected, become more aggregated together, and acquire a common covering, in proportion as their evolution is carried further; and thus is produced a parenchyma or solid organ.

10. The capillary blood-vessels are for the most part much more minute than the smallest branches of the ducts of secreting canals and their cæcal extremities, even in the most complex glandular organs. The elementary parts of glands, though minute, are of such a size that the capillary blood-vessels form around them a network which invests them.

11. The formation of the glands in the embryo displays the same progressive evolution from the simple to the complex state as is observed in ascending the animal scale. The most perfect and complex glands of the higher animals, when they first appear in the embryo of these animals, consist merely of the free efferent ducts without any branches, and in that state exactly resemble the secreting organs of the lower animals. The glands are formed from the unbranched tubes by a kind of efflorescence or ramification.

12. The mode in which the extent of internal secreting surface of a gland is realised is very various; and no one kind of conformation is peculiar to any kind-of gland. Perfectly different glands may have a similar elementary structure, as is the case, for instance, with the testes and the cortical substance of the kidneys. And similar glands have often a perfectly different structure in different animals; of which the lachrymal glands, examined in the chelonia, birds, and mammalia, afford an example.

Johannes Müller, recognised thoroughly, as we have seen, that the character of a secretion cannot be deduced from the structure of the organ which produces it. Was he able to throw any light upon the mystery which had baffled his predecessors and to explain the cause of the specific endowments of the different glandular organs? Let us allow Müller to speak:—

"The peculiarity of secretions does not depend on the internal conformation of the glands; for, as I have sufficiently demonstrated, each secretion is in different animals the product of the most various glandular structures, and very different fluids are secreted by glands of similar organisation. The nature of the secretion depends therefore solely on the peculiar vital properties of the organic substance which forms the secreting canals, and which may remain the same, however different the conformation of the secreting cavities may be; while it may vary extremely although the form of the canal or ducts remain the same." It was the living lining substance of the gland which, according to Johannes Müller, formed the secretion, at the expense of materials which it obtained from the blood of contiguous capillaries. This living substance lining the inner recesses of the glands had not yet been differentiated into its constituent units, the secreting cells, and therefore Müller's statement wanted a certain definiteness, though, so far as he went, he was perfectly accurate.

The Researches of John Goodsir.

The success with which that eminent pupil of Johannes Müller, Theodore Schwann, had extended the generalisations of Schleiden (on the part taken by the cell in the formation of vegetable structures) to the elucidation of the animal tissues, had given the greatest impulse to the study of animal histology, and a large number of observers, especially in Germany and England, were directing their attention to the discovery and study, in all tissues and organs, of the all-important cells.

Purkinje had announced the hypothesis that the nucleated epithelium which he discovered to line the gland ducts might exercise secreting functions. Henle had described with great minuteness the epithelium cells which line the ducts of the principal glands and follicles, and which form the most superficial structures of mucous membrane, and Schwann had suggested that this epithelium probably played a part in the act of secretion. It was, however, unquestionably the Scottish anatomist, John Goodsir, to whom was reserved the merit of establishing in an indisputable manner the fact that the essential and ultimate secreting structures in glands are the morphological units, the gland cells. As Johannes Müller had examined the arrangements and coarser structure of glands throughout the animal kingdom, with the result of discovering the general plan of gland-structure, and the analogies existing between glands, however diverse, so John Goodsir passed under review the histological characters of the cells of different glands in a large variety of animals, vertebrate and invertebrate. His first results were published in the "Transactions of the Royal Society of Edinburgh" for the year 1842; his more matured views were developed in a paper entitled "On Secreting Structures," which formed one of a collection of papers which saw the light in 1845. As a result of his survey Goodsir came to conclusions of which the most important may be stated, almost in his own words, as follows:—

"The ultimate secreting structure is the primitive cell endowed with a peculiar organic agency, according to the secretion it is destined to produce. I shall henceforward name it the primary secreting cell.

"Each primary secreting cell is endowed with its own peculiar property, according to the organ in which it is situated. In the liver it secretes bile, in the mamma milk, &c.

"The primary secreting cells of some glands have merely to separate, from the nutritive medium, a greater or less number of matters already existing in it. Other primary secreting cells are endowed with the more exalted property of elaborating, from the nutritive medium, matters which do not exist in it.

"The discovery of the secreting agency of the primitive cell does not remove the principal mystery in which the function has always been involved. One cell secretes bile, another milk; yet the one cell does not differ more in structure from the other than the lining membrane of the duct of one gland from the lining membrane of the duct of another. The general fact, however, that the primitive cell is the ultimate secreting structure, is of great value in physiological science, inasmuch as it connects secretion with growth, as phenomena regulated by the same laws."

Goodsir was unquestionably wrong in certain of his speculations concerning secreting cells; as, for instance, in attributing at one time the chief part in the process of secretion to the cell wall, at a later period ascribing the same function to the cell nucleus. He certainly had not grasped the modern idea, which, as I shall afterwards more particularly point out, considers the act of secretion as one of the results of the activity of the living protoplasm of the cell. His assumption, too, that the secreting cell invariably contains, preformed, the characteristic matters of the secretion, is one which is by no means generally true. Nevertheless, it is impossible to study Goodsir's researches on the secreting cell, without ascribing to him the merit of having been the one who made the most important generalisation, connecting cell life with a definite organic function.

I may be permitted, as it were parenthetically, to refer for a moment to John Goodsir, with the veneration which is natural in one who was his pupil. If it be true that the rapid march of scientific discovery has caused us well-nigh to forget the great debts which we owe to Johannes Müller, it is no less true that John Goodsir's name has passed into premature and undeserved oblivion. Goodsir's was a mind which in some respects, especially in its tastes, resembled that of Müller. He was a devoted anatomist, and studied morphology in the first instance for its own sake, but also because of the light which it sheds on organic function. He had a powerful intellect, an insatiable thirst for knowledge, a sympathy with all branches of inquiry which could throw light upon the science to which he devoted his life, and a devout and reverential spirit, which was not the less strong because it only rarely found audible, though then it was emphatic, utterance. In the earlier part of his scientific career, numerous papers, for the most part short, but characterised by remarkable originality of observation and freshness of thought, seemed to promise that Goodsir would be one of the most productive of the workers of his time. A lingering illness which, without altogether disabling him, enfeebled his physical powers, and cast a gloom upon a life which had promised so much, almost put an end to his career, in so far as the scientific world at large was concerned, and henceforward he devoted his remaining energies to studies of which the results were for the most part not published, but especially to the task of teaching. Goodsir was a master who, if judged of by the low standard of fitness to instruct the great majority of his pupils in such a manner as to enable them successfully to pass examinations, would occupy no exalted position. He possessed, however, the far rarer power of instilling into the minds of the best of his pupils that love of original inquiry, and that deep regard for truth which are the chief incentives to all scientific research of any real value.

The Investigations and Theories of Bowman.

At the time when Goodsir was engaged in his investigations and speculations relating to cells, Mr. Bowman was making researches which were to give him a lasting place among the great histologists of the century.

His investigations on the structure of the kidney,[1] which was published in the "Philosophical Transactions" for the year 1842, surpassed in completeness as an anatomical study, no less than by the deep insight into the nature of the function discharged by the organ, any investigation of like kind which had preceded it. It not only led to a more complete knowledge of the structure of the kidney than was possessed of that of any other gland, but to far-seeing generalisations concerning the structure of mucous membranes, and of secreting organs generally, which found expression in a masterly article on mucous membranes, published in the year 1847, in the "Cyclopædia of Anatomy and Physiology."

Time will not permit of my giving a complete analysis of the (to use a German expression) epoch-making research upon the kidney; but let me remind you that it led to a complete understanding of the relations of the Malpighian bodies to the urinary tubules; to a description which, so far as it went, was perfectly accurate of the tubules themselves, though the scheme upon which these tubes are arranged has, since Bowman's time, thanks to the labours of Henle, Ludwig, and Schweigger-Seidel, been proved to be more complicated than he had imagined, and to a knowledge of the distribution of blood-vessels, not only in the kidney of man and other mammalia, but also in that of certain reptiles.

His study of the structure of the tubuli uriniferi had led Mr. Bowman to discover that in these, a layer of epithelial cells lies upon a structureless membrane, to which he gave the name of the *basement membrane*,[2] and which intervenes between the epithelium and the blood capillaries, whence the materials of secretion are primarily derived. His examination of the mucous membranes of the body led Bowman to the conclusion that the relationship so easily observed in the case of the kidney between cells, basement membrane, and blood-vessels, is one which holds true, not only in the case of that organ but in that of many other epitheliated structures.

"In the mucous tissue," said Mr. Bowman (Article, *Mucous membrane*, in Todd's "Cyclopædia," p. 436), "there are two structures which require to be separately described, viz., *the basement membrane* and *the epithelium.* The basement membrane is a simple homogenous expansion, transparent, colourless, and of extreme tenuity, situated on its parenchymal surface and giving it shape and strength. This serves as a foundation on which the epithelium rests. The epithelium is a pavement composed of nucleated particles adhering together, and of various size, form, and number. The following general observations on these elementary parts will receive illustration as we advance. Neither the one nor the other is peculiar to the mucous tissue in the sense either of being invariably present in it, or of not being found elsewhere. There are certain situations of the mucous system where no basement membrane can be detected, and others from which the epithelium is absent. Both, however, are never absent together. Again, a structure apparently identical with the basement membrane is met with in numerous textures besides the mucous, and all internal cavities, whether serous, synovial, or vascular, or of anomalous kind (as those of the thymus and thyroid body), are lined by an epithelium."

As a result of his anatomical studies on the kidney, Mr. Bowman was led to frame a theory of renal secretion, which, though opposed for a time by a master mind, has, by the progress of research, received complete confirmation, and which was based in no small degree upon the new views of the function of epithelial cells in glands. The Malpighian body, Bowman showed, is the dilated commencement of a convoluted tubule, and, like it, presents a delicate, structureless, basement membrane. Into the Malpighian body projects a tuft of capillary vessels, continuous, on the one hand, with an afferent vessel derived from a branch of the renal artery, on the other, with an efferent vessel of smaller size than the afferent; both afferent and efferent vessels piercing the capsule of the Malpighian body; after leaving the glomerulus, the efferent vessel breaks up into a series of capillaries, which are distributed to the walls of the convoluted tubes. The tuft of blood-vessels projecting into the Malpighian body, Bowman described as being perfectly bare, that is to say, not covered by a basement membrane, or by a layer of epithelium cells. This part of his description has not been confirmed by recent work, the more delicate methods of modern histology allowing of a ready demonstration of a layer of cells of extreme tenuity covering the glomerulus.

The basement membrane of the convoluted tube was described as lined by a nucleated epithelium of a finely granular opaque aspect; the neck of the tube, where it joins the Malpighian capsule, and the contiguous portions of the capsule were described as covered by a layer of cells, differing altogether from the first, being much more transparent, and possessing in certain animals vibratile cilia. In some cases the whole interior of the capsule was lined by epithelium cells of great delicacy and tenuity; in others, these cells could not be traced over more than a third of the capsule. Basing himself upon the altogether exceptional arrangement of the blood-vessels of the glomerulus, Bowman advanced the theory that this is a structure destined to separate from the blood its watery portion. The epithelium of the convoluted tubes on the other hand, which Bowman pointed out to be eminently allied to the best marked examples of glandular epithelium," he believed to be concerned in the separation of the characteristic solid matters of the renal secretion.

I shall for the present conclude my remarks upon Mr. Bowman's investigations and theoretical views by stating that, by his investigations of the blood-supply to the kidney of the boa constrictor, he gave the strongest proofs which could be derived from anatomical evidence of the correctness of his views, and furnished great part of the knowledge required for the subsequent researches which Nussbaum made on the secretion of the newt's kidney, and which afforded the most conclusive experimental evidence in favour of the theory which Bowman had advanced.

The Discoveries of Carl Ludwig.

If to Johannes Müller we must ascribe the greatest share of merit as a discoverer of the general affinities, relationships, and functions of glands, it appears unquestionable that to Carl Ludwig belongs the credit of having, above all others, brought the light of experimental physiology to bear upon the subject of secretion.

Ludwig is one of the most eminent of the physiologists who have endeavoured, as far as possible, to apply the conceptions derived from a study of physical and chemical processes in general, to the elucidations of the functions of the organism. More than anyone else has he successfully adapted the methods of research of the chemist and of the physicist to the investigation of the problems which lay before him. Above all others he is to be spoken of as the great teacher amongst all of the great teachers of physiology which this century has produced. If we try to find one who, from the fertility of his mind and the influence which he had upon men of ability, affected the progress of his science in like measure to Ludwig, we revert to the name of Liebig. When I say that physiology owes as much to Ludwig as chemistry to Liebig, I shall, I feel sure, be doing but scant justice to the great man, who at Marburg, at Vienna, and at Leipzig, has won for himself the right to be called at once the greatest physiologist, and the greatest teacher of physiology, of his time.

1. *Ludwig's Discovery of Secreting Nerves.*—It was in the year 1851 that Ludwig first announced to the scientific world (Ludwig, "Neue Versuche über die Beihilfe der Nerven zur Speichelabsonderung," Henle & Pfeifer's *Zeitschrift*, New Ser., vol. i. (1851), p. 255) the fact that the secretion of the salivary glands is under the influence of the nervous system. C. G. Mitscherlich, as Ludwig points out, had surmised that the secretion of saliva only occurs as the result of a stimulation of certain nerves. *i.e.*, the nerves of taste and the nerves supplying the muscles of mastication. No attempt had, however, been made, before Ludwig's, to ascertain experimentally whether the stimulation of nerves supplying glands influenced directly their secretion. As a subject of study Ludwig chose the submaxillary gland. He found that on stimulating by a succession of induc-

---

[1] W. Bowman, "On the Structure and Use of the Malpighian Bodies of the Kidney, with Observations on the Circulation through the Gland," *Philosophical Transactions* for the year 1842, Part I., p. 57.

[2] *Op. cit.*, p. 58.

tion shocks the nerve twigs proceeding from the lingual branch of the fifth nerve, and which accompany Wharton's duct to the gland, secretion of saliva occurred, so long as the excitability of the nerves persisted.

In experiments performed in conjunction with his pupil Rahn, Ludwig found that secretion occurs on direct stimulation of the glandular nerves, even when the circulation has been arrested for a time, as for instance, when the contractions of the heart are exhibited for some time.

2. *Ludwig's Discovery that Secretion is not a Process directly dependent upon the Arterial Pressure.*—In the paper which I have already quoted, Ludwig published the results of the following experiments. A mercurial gauge was placed in communication with the duct of the submaxillary gland, the height ot the mercury in the guage being recorded (by means of a float to which was attached a writing point) upon the travelling surface of the kymographion, the instrument which Ludwig had contrived for permanently recording the amount and variations of the blood pressure in arteries and veins. At the same time, another gauge placed in communication with the carotid artery, or one of its branches in close proximity to the gland, recorded the height of the blood pressure on the same travelling surface. On stimulating the secretory nerves, Ludwig found that saliva was poured out long after the pressure exerted by it upon the interior of the gland (as measured by the height to which the mercury was raised in the gland-duct manometer) exceeded the pressure of blood in the arteries. Thus in his first recorded experiment the mean pressure of blood in the carotid artery amounted to 108·5 millimetres of mercury, whilst during a stimulation of the nerve filaments going to the gland, the pressure in the gland-duct manometer rose to between 190·7 and 196·5 millimetres, *i.e.*, indicated that the pressure exerted by the fluid, secreted under the influence of nerve stimulation, exceeded the arterial pressure by an amount corresponding to a column of mercury about 3½ inches high. It is obvious that the experiment at once and conclusively proved that the secretion of a watery liquid like the saliva may be brought about by a process altogether different from a process of filtration; for in filtration the passage of liquid through the minute pores of the filter necessarily depends upon a difference in pressure on the two sides of the filter, the movement of liquid being from the side of greater to that of lesser pressure.

In this brief sketch I have only time to refer to the most salient of the early discoveries of Ludwig on secretion, and must pass over without comment the first experiments by which he showed the influence exerted by variations in the strength of the stimulus of secretory nerve upon the amount and chemical composition of the secreted liquid.

3. *Ludwig's Discovery that during Secretion Heat is evolved in Glands.*—Pursuing his researches on the salivary glands, Ludwig. some years later, (Ludwig u. Spiess, "Sitzungsber. d. Wiener Akad. Mathem. u. Naturwissenchaft: Classe," vol. xxv. (1857), p. 548,) in conjunction with his pupil Spiessi discovered that, when a gland is thrown into action by stimulation of its nerves, heat is evolved. In the case of the submaxillary gland, for instance, he found that the saliva which was secreted might have a temperature nearly three degrees Fahr. (1·5° C.) above that of the blood going to the gland. Important as was this result because of the light which it threw upon the source of animal heat, its value as bearing upon the nature of the process of secretion was even greater. From the fact that the saliva is a liquid containing but three or four or five parts of solid matters to one thousand of water, it would scarcely have been surmised, upon a merely physical hypothesis, that its production would have been attended by any considerable evolution of heat. The evolution of heat is indeed one of the strongest proofs we have that the act of secretion is the result of the living activity of those ultimate units of the glands, the gland cells; but to this I shall revert hereafter.

The Researches of Schiff, Eckhardt, and Claude Bernard, on the Secretory Nerves of the Salivary Glands.

The study of the innervation of the salivary glands which had been commenced by Ludwig and Rahn was continued with great success by other observers, and particularly by Claude Bernard and Eckhardt. The first of these observers proved the correctness of Schiff's supposition that the abundant secretion which followed the stimulation of fibres of the fifth cranial nerve was in reality due to the presence of fibres of the chorda tympani mixed with them. It was Eckhardt, however, and afterwards Claude Bernard, who established the remarkable fact that, in the case of the submaxillary gland, and, as has since been shown, of some other glands also, the gland is under the direct control of two orders of nerve fibres. The first are contained in branches of cranial nerves, and in the case of the submaxillary gland are derived from the facial nerve, and, when stimulated, lead to an abundant secretion of watery saliva, relatively rich in saline and poor in organic constituents; the second are contained in the so-called sympathetic nerve trunks distributed to the gland; and these, when stimulated, occasion an exceedingly scanty flow of very concentrated and highly viscid saliva, containing a relatively large quantity of organic constituents, particularly of mucin.

Claude Bernard now pointed out that stimulation of the above-mentioned nerves leads to changes in the circulation of blood through the gland, in addition to the changes in the amount and quality of the fluid secreted by it.

Thus stimulation of the cerebral fibres supplying the chorda tympani was found to produce a great dilatation of the arteries of the gland; so that the amount of blood passing through it was very largely increased, that passing out through the venous trunks of the gland presenting a florid arterial colour instead of the brown venous hue observed when the gland was not secreting. Stimulation of the sympathetic fibres, on the other hand, caused a great contraction of the glandular arteries, consequently a diminution of the flow of blood through the gland and into the veins, the blood presenting under these circumstances an intensely venous hue.

The facts just referred to appeared reconcilable at first with the view that the secretion of saliva, as a result of nerve stimulation, was primarily dependent upon changes in the circulation of blood through the gland; though, upon reflection, the surmise was negatived by some of the facts discovered long before by Ludwig, and particularly by that, already referred to, of glandular secretion following stimulation of glandular nerves, even where the circulation has been stopped, as by cardiac inhibition.

Bernard's experiments had unquestionably established that in addition to nerves which, when stimulated, occasioned the contraction of arteries—"the vaso-motor" or, as we now sometimes call them, the "vaso-constrictor" nerves—there are others which when stimulated occasion, on the contrary, the dilatation of arteries—the so-called "vaso-inhibitory" or "vaso-dilator" nerves. That it was not stimulation of the vaso-dilator nerves, which, by increasing the amount and the pressure of the blood flowing through the capillaries, occasioned the secretion of saliva, was shown by several experiments, but especially by an observation of Keuchel. This observer found that the alkaloid of the deadly nightshade, viz. atropia, when introduced into the system, exerts such an action, that on stimulating the chorda tympani no secretion of saliva follows; whilst, on the other hand, dilatation of the arteries is produced exactly as under normal circumstances. Other drugs have since been discovered which exert a similar action to that of atropia in paralysing secretory nerves, whilst some are now known which antagonise the action of atropia, and restore the suspended activity of the secretory nerves. From these studies has unquestionably resulted a knowledge of the conclusion, that although the process of secretion is favourably influenced by the vascular dilatation which follows the state of activity of the vaso-dilator nerves, the actual process of secretion is not due to them, but, so far as it is controlled by the nervous system, is directly under the influence of certain nerves which may be termed secretory.

Discoveries which show that Secretion, though influenced by, is not necessarily dependent upon, Stimulation of Nerves going to a Gland.

A knowledge of the facts which I have brought before you hitherto would of itself lead you to suppose that glandular secretion is a process which is in abeyance except under the influence of stimulation of nerves which throw the gland into activity, in the same manner as the quiescent muscle passes into activity normally, only when its motor nerves are stimulated. But this supposition, though it may be in some measure true in the case of certain glands, is not borne out by a study of secreting glands in general—a study which teaches us that whilst the activity of the gland cells may be, and often is, remarkably under the control of the nervous system, it is by no means necessarily dependent upon it. The activity of the gland depends upon the activity of its individual units, the gland cells; and these units may discharge their function so long as they continue to live and are supplied with the nutriment—mineral, organic, and gaseous, which they require.

Leaving aside, at least for the present, any reference to the arguments which may be derived, by analogy, from a study of cell life in general, I would call your attention to the physiological facts which prove the truth of the proposition just enunciated. The first of these facts was discovered by Claude Bernard; to wit, that when all the nerves supplying the salivary glands are divided, there is at first a temporary cessation of secretion, soon followed, however, by an abundant flow of very watery, so-called paralytic saliva.

This result is fully confirmed by similar observations made in the case of other secreting organs, and which establish very fully the greater or less independence of the secreting elements from the control of the nervous system; though unquestionably, in a normal state of the organism of higher animals, the nervous system is continually intervening, both directly by its influence on gland cells, and indirectly by the changes which it produces in the circulation, so as to control the operations of gland cells, and especially to bring them into relation with, and subordinate them to, the work of complex processes of the organism.

What the exact relations of nerve fibres to gland cells may be is yet a matter involved in great doubt. The discovery made by Pflüger of the terminations of nerve fibres in the secreting cells of the salivary glands has not been confirmed by any observers in any vertebrate. Kupffer has, however, unquestionably done so in the case of *Blatta orientalis*, and although as yet objective proof is wanting, we cannot entertain any reasonable doubts that a connection between the ultimate fibrillæ of nerves and secreting cells actually exists. We feel confident that physical, as it were accidental, difficulties have alone hindered the precise determination of the fact.

The Immediate Source of the Nutriment consumed by the Gland Cell.

In the original scheme of a secreting gland, developed first of all by Bowman, then adopted by Goodsir, Carpenter,[1] and many other writers, the essential structural elements taken into account were the following:—1. Epithelial cells lining the secreting cavity of the gland; 2. Sub-epithelial tissue, usually presenting superficially the form of a basement membrane, upon which the cells were placed; and 3. A capillary network in closer relation to the basement membrane, or more superficial part of the sub-epithelial tissue. In harmony with this scheme, the glandular elements were always spoken of as drawing their supply from the blood in the capillaries. The one element which was wanting in that scheme, and which we are able to fit into it, thanks again to the labours of the great physiologist of Leipzig, is the relation of so-called lymph spaces to the other elements. As was first shown by the researches of Ludwig and his school, amongst the modes of origin of the peripheral lymphatics, the most numerous are to be found in connective tissue, and nowhere more abundantly than in the connective tissue of glands, which is everywhere interpenetrated by irregular spaces containing lymph, from whence spring the minutest lymphatics. If we consider, then, the immediate environment of the secreting cell, we find that in close proximity to it is the lymph, which is a transudation from the blood, and upon which the gland cells are directly dependent for all the matters which they require For a certain time, then, the gland cell will be independent of the supply of blood, that is, so long as the lymph surrounding it contains a sufficient quantity of essential matters, of which oxygen is one of the chief, to support its life, or until it becomes so charged with waste products derived from cell life, *e.g.* CO_2, as to interfere with the functions of the latter. It certainly appears that, at least in the majority of cases, it is the secreting cell which modifies, in the first instance, the composition of the lymph which bathes the tissues in proximity to it, rather than the composition of the lymph which modifies the activity of the gland cell. There are some cases nevertheless in which it would appear that the presence of certain constituents in the lymph is the direct cause of the activity or increased activity of the cells.

Secreting Cells present different Appearances, corresponding to different States of Functional Activity. The Researches of Heidenhain.

Amongst the physiologists of Europe who have most enriched science by their researches during the last thirty years is unquestionably Professor Heidenhain of Breslau, who has exhibited his mastery of the physical side of physiology by his classical research on the relations between the heat evolved in and the work done by muscle, and as a biologist able to use in the best manner all the resources of modern histology in the elucidation of bodily function, by the researches to which I wish to direct your attention for a few moments.

The glands imbedded in, or the ducts of which open upon the surface of the mucous membrane of, the alimentary canal, for the most part, are characterised by periods of more or less complete cessation of activity, as judged by the diminution, or absolute cessation, of the secretion which they prepare. This is true of the salivary glands and of the liver, but particularly true of the gastric glands and the pancreas.

Certain of these glands, *i.e.* the salivary glands in some animals, and the stomach and pancreas in all in which they exist, have the task of preparing juices which contain certain so-called unformed or unorganised ferments or *enzymes*, upon which the properties of the secretions in great measure depend. Heidenhain in a long series of investigations, which have been taken part in by certain other scientific men, as by Ebstein and Grützner, by Kühne and Lea, and particularly by Mr. Langley of Trinity College, Cambridge, has shown that the secreting cells of a particular gland, as for instance of the submaxillary gland, of the gastric glands, and of the pancreas, exhibit differences in size, differences in the form and appearance of the nucleus, and differences in the cell contents, corresponding to varied states of functional activity.

Time will not permit my mentioning in detail the results of these observations from which, however, certain general conclusions appear derivable. Thus, a gland cell at rest is usually larger than a similar cell which has been engaged in the process of secretion; from its behaviour to reagents, it usually appears to contain within itself an abundant store of the body or bodies which are chiefly characteristic of the secretion, or closely related antecedents of these, and the amount of undifferentiated protoplasm surrounding the nucleus appears to be at a minimum. On the other hand, the gland cells, which have been secreting for a greater or less period, often, though not invariably, present a diminution in their size, a diminution in the amount of the characteristic bodies previously referred to, and an increase in the protoplasmic constituents of the cell. All facts, histological as well as physiological, seem to point to the following conclusion: that during rest, the cell forms, at the expense of, or as the product of the differentiation of, the cell protoplasm, the bodies characteristic of the secretion; that whilst secretion is going on these leave the gland cell; and that, at the same time, the protoplasmic constituents of the latter increase at the expense of the lymph, to be converted secondarily, either at a later period in that particular act of secretion, or in the succeeding period of inactivity, into specific constituents. The researches of Heidenhain have been conducted upon the glands after these had undergone processes of hardening and straining, the appearances observed indicating changes which, though not identical with, at least corresponded to various conditions of the gland. Kühne and Lea and Langley have, however, studied glands in a living condition, and though the appearances were not identical with those observed by Heidenhain, they entirely confirm these.

I have not time to do more than refer to the fact that in some at least, though probably in all of the cells of glands which produce secretions containing ferments, there are formed at first bodies to which the generic term of "*zymogens*" may be applied, i.e. *ferment generators*, from which a ferment is afterwards set free.

In connection with this part of my subject I may refer to the view, which was at one time held by some, that in secreting glands the gland cell having produced the matter of the secretion was thrown off, discharging its contents into the secretion. This process, when it does occur, must be looked upon as exceptional, and as it were accidental.

Amongst the most striking examples of the success with which physiological experiment and subsequent histological research have been pursued in combination so as to throw light upon the functions of particular cells, I may refer first to the observations of Heidenhain, secondly to those of Nussbaum on the excretion of colouring matters, artificially introduced into the blood, by the secreting epithelium cells of the renal tubules. I have previously referred to the theory of Bowman, according to which the watery and saline constituents of the renal secretion were

---

[1] Carpenter in his admirable article on "Secretion" in "Todd's Cyclopædia of Anatomy and Physiology."

supposed to be separated by the so-called "*glomeruli*," whilst the organic solids of the secretion were supposed to be separated by the epithelium lining the convoluted tubes.

To this theory was opposed that of Ludwig, according to which the whole of the constituents, watery, saline, and organic, were supposed to be poured out of the vessels of the glomerulus, the amount of water however being far in excess of that contained in the liquids when it reaches the pelvis of the kidney. Ludwig supposed that as the secretion passed over the surface of the epithelium lining the complex tubules, processes of diffusion occurred between it, on the one hand, and the lymph bathing the tissues lying outside of the basement membrane of the tubules on the other, the direction of the current of water being from without inwards. The anatomical evidence adduced by Bowman was of itself well-nigh sufficient to prove the accuracy of his views, which have however been placed beyond all dispute by the following observations: Heindenhain introduced into the blood a solution of sulphindigotate of sodium, usually some time after having divided the spinal cord in the cervical region. On killing the animal some time afterwards and subjecting the kiney to careful examination, it was found that the colouring matter had been accumulated by the epithelium of the convoluted tubules from the lymph bathing the tissues, and which contained so little colouring matter as to appear colourless. If a sufficient time had elapsed after the injection, the colouring matter was found in the form of granules or minute crystals lying on the inner side of the cell in the lumen of the tubules.

Bowman, as I have already mentioned, had in the case of the boa constrictor studied in detail the blood supply to the organ, which, as Jacobson had shown, differs in fishes, birds, and reptiles, from the mode of arrangement prevailing in mammals.

Bowman had shown that in the boa the glomeruli derived their blood exclusively from the renal artery, and the convoluted tube exclusively from the common iliac vein. Nussbaum gave absolute completeness to the proof of Bowman's theory by the following remarkable experiment. Experimenting on the newt, in which the blood-supply of the kidney is similar to that of the boa, he found that, when he tied the renal artery, he arrested almost entirely the secretion of water in the kidney, but that the excretion of urea and other solid matters, and amongst others of the colouring matter already used by Heidenhain, viz., indigo carmine, continued. Ligature of the renal branches of the common iliac vein stopped the secretion of organic solids without impeding that of water.

THE MOST RECENT THEORIES ADVANCED IN EXPLANATION OF THE PHENOMENA OF GLANDULAR SECRETION.

Having brought before you the most salient facts with which we are acquainted, which appear to throw the most light upon the general physiology of glandular secretion, I wish, before concluding, to speak of the theoretical views which have been advanced in explanation of a large number of the facts.

In the first place, I have to confess that our ignorance is absolute as to the cause of the specific endowment of different secreting cells, in virtue of which they produce new bodies at the expense of certain of the materials supplied to them by the lymph, or separate particular constituents from the lymph, to the exclusion of others which are equally abundant in the liquid. We express the full measure of our ignorance when we state that the difference in function of different gland cells is due to differences in endowment of the protoplasm of the cell, which in no case is explained by any objective characters of the cell.

The phenomena of the secretion of water, which forms so large a part of every secretion, have given rise, however, to numerous speculations, concerning which I may make a few remarks.

The primitive view that the glands are organs in which is strained off from the blood water holding certain substances in solution has, in a modified manner, found favour with some even to our own days, and appears indeed, at first sight, to be borne out by certain facts. Thus within wide limits the amount of water secreted by the kidney depends upon the pressure of blood in the glomeruli. Any circumstances which will lead to an increase of pressure in these vessels (as increase of blood pressure generally, division of renal nerves, division of the splanchnics, especially when combined with stimulation of the spinal cord), by dilating the branches of the renal artery, will lead to this result. At first this would seem to show that the process of separation of water, in the kidney at least, is but a process of filtration, though a remembrance of the famous experiment of Ludwig, referred to at an earlier period, on the relation between the pressure of secretion of saliva and that of the blood in the arteries, would impose caution in drawing the conclusion. What are the facts, then, relating to the blood pressure in vessels in other organs of the body, and the transudation of liquid from them?

If an increased arterial pressure led *ipso facto* to an increased transudation through the capillary walls, it would follow that the amount of lymph and the pressure of the lymph-stream would rise with the rise of the arterial pressure, but direct experiments on this matter have led to an opposite conclusion. The experiments of Paschutin and Emminghaus, carried out under Ludwig's direction, have shown that when the arterial pressure in the extremities is increased, there is no corresponding increase in the lymph produced. Again, when the chorda tympani is stimulated in an animal into whose blood atropia has been introduced, the vascular dilatation which is produced, and which is produced, and which is then unaccompanied by secretion, does not lead to an increased production of lymph, which would make itself evident by the gland becoming œdematous. How then are we to account for the flow of water through a gland? By ascribing it to an influence which is exerted by the gland cell, in the first place, upon the liquid which environs it, viz. the lymph. And accordingly, even in the case of the glomeruli of the kidney, we conclude that the water is separated as a direct result of the activity of the layer of transparent epithelium cells which cover them. Hering has advanced a strictly physical theory, which wou'd account for the mode in which certain cells exert this influence, by supposing that there is produced within them bodies which, like mucin, have a great affinity for water and which then pass into the secretion; and which therefore lead to a current of water passing through the cell; but the theory is one which cannot be admitted, because, as Heindenhain points out, the passage of water through a gland occurs in cases where there is no constituent in the cells, at all resembling mucin in its affinities or behaviour towards water.

I feel inclined to say that the speculations, necessarily indefinite though they are, of Professor Heindenhain afford the best explanation of the phenomena. Heindenhain starts from the fundamental fact that during secretion only as much water passes out of the blood-vessels of the gland as appears in its secretion, seeing that, however long the process of secretion may continue, the gland never becomes œdematous, nor does the current of lymph from it increase.

The volume of liquid filtered through the blood capillaries adjusts itself exactly to the volume of liquid separated by the cells. This equality in the amount of liquid secreted and filtered appears only explicable on the supposition that the act of secretion is the cause of the current of water—in other words, that the water which the cells lose in the formation of the secretion generates changed in them which can only be compensated for by an abstraction of water from the immediate environment.

Within certain limits, Heindenhain continues, we may form purely physical conceptions of the process. We may conceive, for instance, the whole protoplasm of the cell to have a certain affinity for water. The cells at their contact with the basement membrane may be supposed to be able to abstract water from it; the loss which the membrane sustains will be made up by the lymph, and this again will influence the blood in the capillaries.

The passage of water into the cells will go on until a period of equilibrium is attained; but at that time the current of water from the capillaries through the lymph to the cells will cease. We may conceive further, reasons Heidenhain, that the passage of water out of the cell is hindered by such obstacles to the process of filtration as are represented by resistance opposed to it by the superficial border layer of protoplasm. If we now conceive that, for example as a result of nerve stimulation, the gland cells pour out water, the condition of equilibrium which existed between cell, basement membrane, lymph, and capillary will be disturbed, and a current of liquid set in from the last to the first, and continue as long as the activity of the cells continues.

It is not difficult moreover, Heidenhain remarks, to form physical conceptions of the processes whereby water may be separated from the cell itself. It is conceivable, for instance, that the protoplasm of the cell may contract after the manner which occurs in many infusoria, and which in them leads to the accumulation of water in droplets, forming vacuoles, except that in the case of the secreting cells the water is poured out on the outside and not on the inside of the cells. Or, again, it is possible that on the gland cell passing into the condition of activity an increased production of CO_2 may occur, leading to an increased diffusion of water outwards.

So far, I have quoted Professor Hedenhain, for the most part in his own words. Let me add, however, that the two hypotheses which he advances as possible explanations of the mechanism of secretion of water by the cell rest upon the most probable grounds, as upon the presence of the intra-cellular protoplasmic network which has been so beautifully demonstrated by recent researches, and especially by those of Professor Klein; or, again, upon the fact, proved by the analyses of Professor Pflüger of the gases of the saliva, that there is during secretion great production of CO_2, as shown by the amount of this gas in the saliva being much greater than in the blood, and upon the fact of the remarkable diffusibility of acid solutions.

Reasoning upon a large number of facts, which I have not time to refer to, Professor Heidenhain has come to the conclusion that, quite apart from the nerves which control the vascular supply to a gland, there exist two distinct sets of nerve-fibres in relation to the glandular elements. The first of these, which he terms "secretory," when stimulated, lead to the secretion of water and saline constituents; the second, which he terms "trophic," influence the transformations of the protoplasm of the cell, and thus affect the organic constituents of the secretion.

I do not wish to pronounce a definite opinion concerning this hypothesis, but would remark that the nomenclature proposed by Heidenhain appears to me to be an unfortunate one, especially because it attaches a new meaning to a word which had previously been used by physiologists in a different sense. I refer to the adjective *trophic*, which has always implied "governing nutrition." It appears to me almost inconceivable that if there exist two sets of secretory nerves, the action of each should not profoundly affect the nutrition of the cell protoplasm, though, of course, it is conceivable that they should do so in very different manners.

GENERAL CONCLUSIONS.

The complicated studies, of which I have attempted to give you a brief sketch, have led to our forming certain clear general conceptions in reference to the process of secretion. They have brought into greater prominence the dignity, if I may use the expression, of the individual cell. The process of secretion appears as the result of the combined work of a large number of these units. Each, after the manner of an independent organism, uses oxygen, forms CO_2, evolves heat, and derives its nutriment from the medium in which it lives, and performs chemical operations of which the results only are imperfectly known to us, and which depend upon peculiar endowments of the cell protoplasm, of which the causes are hidden from us. So long as the protoplasm is living, the gland cell retains its power of discharging its functions, and in many cases does so, so long as the intercellular liquid furnishes it with the materials required. In some cases, however, the gland cells are specially sensitive to a variation in the composition of the nutrient liquid, certain constituents of which appear to stimulate the protoplasm to increased activity. In the higher animals the cells, particularly in certain glands, are in relation to nerves which, when stimulated, affect in a remarkable manner the transformations of their protoplasm, leading to an increased consumption of oxygen, an increased production of carbonic acid, an increased evolution of heat, and an increased production of those matters which the cell eliminates and which constitute its secretion.

This historical survey of the growth of our knowledge of the process of secretion exhibits the characteristic features of biological advancement. Comparative anatomy has been the foundation of observation of facts and physical experiment, the road to physiological research. At various stages the value of hypotheses has been well illustrated, and, whenever they have had to make way for the broader and truer interpretations suggested by the accumulation of facts and greater precision of observation, it has been demonstrated that the process of observation is not one of simple sight but of complex ratiocination.

NOTES

A MEDAL and Prize, of the annual value of twenty guineas, has been founded by Dr. Siemens, F.R.S., "with the object of stimulating the students of King's College, London, to a high standard of proficiency in metallurgical science." It is open to those who have, as Matriculated Students, studied in the Applied Science Department for two years, and who, either in their third year, or, if they remain in the Department for three years, in the succeeding year, make metallurgy a special study. The first award will be made at the end of June, 1883, and will depend partly on an essay on some particular subject, partly on a written examination on the metallurgical lectures, and partly on actual work done in the Laboratory. The subject for the essay for 1883 will be the "Manufacture of Steel suitable for Ship and Boiler Plates." The essays are to be illustrated by freehand sketches and mechanical drawings to scale, and must be sent in to Prof. Huntington on or before June 30.

SIR WOODBINE PARISH, K.C.H. and F.R.S., died, towards the close of last week, at Quarry House, St. Leonards-on-Sea, in the 86th year of his age. Sir Woodbine was long engaged in the diplomatic service, though his name is also known in the scientific world. As far back as 1824 he had been elected a Fellow of the Royal Society, and was a member of several learned societies both at home and abroad; he had been a vice-president both of the Geological and Geographical Societies. His name is well known in the scientific world as having brought to this country the remains of the megatherium, the glyptodon, and other fossil monsters from the plains and valleys of South America, and his work on the natural history, &c., of Buenos Ayres and Rio de la Plata received a high encomium from no less an authority than Baron Humboldt.

THE death is announced of Count Lutke, well known in connection with Russian Arctic exploration, especially in the Novaya Zemlya region.

THE next Congress of Electricians will meet in Paris on October 11. The Members will have to deliberate, as we have already stated: (1) on the determination of the length of the mercury column equivalent to the practical ohm; (2) on the construction of lightning conductors, and influence of telegraphic or or telephonic wires on thunder-storms; (3) on the means of establishing a general system of observations for atmospheric electricity; (4) on the opportunity of using the telegraph system for establishing constant communication between a certain number of meteorological observatories. At the same time a Diplomatic Congress will meet on the protection of cables. It is surmised, moreover, that the former will be presided over by M. Cochery, Minister of Postal Telegraphy, and the latter by M. Duclerc, Minister of Foreign Affairs.

WE learn from the *North China Herald* that Sir Robert Hart, the Inspector-General of the Chinese Maritime Customs, has fully granted his assistance to the project of a China coast meteorological service. Formerly a certain Minister of the Customs Officers voluntarily made observations and sent them to M. Dechevrens, the head of the Siccawei Observatory at Shanghai; but these were frequently interrupted by the observers being transferred to other ports. Sir Robert has now directed that the observations at all the ports and lighthouses be sent to Shanghai regularly. A storm warning service is also being organised in Japan under the superintendence of Mr. Knipping.

THE *equatorial coudé* (bent equatorial) invented and designed by M. Lœwy, is in full operation at the Observatory of Paris. Observations are conducted with it, although the clock is not yet in place. The peculiarity is that in consequence of the bending and the use of two reflecting mirrors, the astronomer can observe all the celestial bodies without moving from his table. The reflected rays are sent to the eyepiece through the axial part of the refractor by a fixed mirror. The object-glass is placed at the end of the movable part, which revolves round the axial part in an equatorial direction. The rays from the stars are received by a reflecting mirror movable with the object-glass and rotating at will, so that it may reflect any celestial object placed in the same R.A. circle. The two motions of the tube in declination and of the mirror in R.A. are given by special handles at the disposition of the observer.

ON Monday night there was an important installation of the Edison electric light in the "Press Department" of the Telegraph Office, St. Martin's-le-Grand, and the work thus carried out solves what have hitherto been considered some difficult problems in the question of electric lighting. The first interesting fact is that the lighting is part of a "system" supplied at a distance from the place lighted, the Edison Electric Light Company having its centre on Holborn Viaduct. The extension to the top room of the General Post Office, which was accomplished last night, is the greatest yet made from one centre, the distance from the dynamo-room of the company's office to the "Press Room" of the General Post Office being 1950 feet. The "Press Room" to which the Edison electric light has thus been supplied is a very busy part of the telegraph department (1200 persons being employed there), which occupies the whole upper floor of the western building in St. Martin's-le-Grand. The Post Office authorities have long been alive to the necessity of replacing gas by electricity, and have tried more than one so-called "system." Under the advice of Mr. Preece, the electrical engineer of the Post Office, the Edison system was attached, and last night commenced its working. The first lighting was soon after 8 o'clock, and when the gas in the Press Room was extinguished, a turn of the switch lighted up fifty-nine incandescent lamps of the well-known pear-shaped pattern, with the carbon of the shape of an elongated horse-shoe. The effect of the change was very marked. In the telegraph room the atmosphere was heavy and heated. In the room lighted by the Edison lamps an even light without any shadow was thrown all over the tables, while the atmosphere, previously heated by gas, sensibly diminished, even in the short space of about twenty minutes.

THE Italian Minister of Public Instruction has agreed to the proposal made to the Government to participate in the international scientific expedition to the Marquesas Islands, in 1883, to observe the solar eclipse which will take place in May of that year. Prof. Tacchini, director of the Astronomical Observatory of the Collegio Romano, has been entrusted with the necessary preparations, and will go to London to purchase various instruments for the study of the important phenomenon.

THE arrangements for opening the new University College of Dundee are so far forward that Mr. William Peterson, B.A. Oxford, assistant to the Professor of Humanity in the University of Edinburgh, has been elected Principal. It is expected that the College will be opened in January next.

THE Marquess of Ripon has telegraphed his acceptance of the Presidency of Yorkshire College.

THE *Bollettino* of the Italian Geographical Society, alluding to the wreck of the vessel hired by Lieut. Bove for the purpose of exploring the channels of the Archipelago of Terra del Fuoco, calls attention to the fact that it was only a ship temporarily hired, and not the vessel fitted out for the Antarctic Expedition. Lieut. Bove left Punta Arenas on April 25, and three of the members of his expedition remained behind to undertake various excursions on land.

WHILST Western Europe and Western Siberia have been complaining of a cold summer, Russia has been grumbling over very hot weather; and the remarks on this subject which the Central Physical Observatory at St. Petersburg has just published in the *Golos* (August 15) are very interesting. The temperature, noticed during July last at St. Petersburg, by thermometers in shade, were certainly above the average, but not so much as might have been supposed from the painful impression produced by the hot weather. The average diurnal temperature from July 1 to 28 was 28°·6 Cels. (17°·3 at 7 a.m.), and as high as 23°·2 during July 16 to 26. It reached its maximum, 27°·1 on July 18, the thermometer showing 32° at 1 p.m. Now, the average temperature of July, as deduced from 137 years' observations at St. Petersburg, being 17°·71, it does not differ very much from that observed in July last. It is true that such continuous hot weather as in July last occurs very seldom, but it was experienced in 1761, 1763, and 1774. In 1757, the average diurnal temperature of thirty-two consecutive days was above 20° with one single interruption, when it was but 19°·3. The maximum for July last being 32°·0, it also does not much exceed the average maximum for July, which reaches 29°, whilst there were years when it was noticed at St. Petersburg as much as 36°·1. As to such days as July 18, when the average diurnal temperature reached 27°·1, they are rare indeed, as such days have occurred only five times since 1757. On the contrary, the temperatures measured by the radiation-thermometer exposed to the sun's rays were exceedingly high if compared with those measured during the last few years. Their averages for July 1 to 28 were, 33°·4 at 7 a.m.; 44°·3 at 1 p.m.; and 17°·9 at 9 p.m.; that is, 12°·5, 7°·0, and 1°·9, respectively, higher than the averages for preceding years. There were in July last nine consecutive days when the radiation-thermometer showed more than 40° Cels. at so early an hour as 7 o'clock in the morning, reaching as much as 42°·8 on July 26; and eight days when the temperature shown by the same thermometer at 1 o'clock was more than 50°, reaching even 57°·8 on July 18. In consequence, the temperature of the surface of the earth rose as much as 23°·6 instead of 18°·7, which is the normal average; it reached even 45°·3, and the average for July 16 to 26 was as high as 41° 2. The evaporation was accordingly great, reaching an average of 2·46 millimetres per day instead of the normal average of 1·89. The average cloudiness in July was only 50 per cent. instead of 56 per cent., and on July 16 to 26 it was only 36 per cent. During these ten days an anti-cyclone was blowing through Russia, its centre being above Northern Russia, and the prevailing winds being from east and south-east. With the appearance, on July 26, of a cyclone in North-Western Europe, the temperature immediately fell, and at many places there were rain and thunder.

THE dynamo-magnetic engines which killed two young men in the Tuileries Garden on the occasion of Fête de la Jeunesse, were not fed by the Brush system as was mentioned not only by us, but also by the several Paris electrical papers. The fact is, we are informed, that during the fête of July 14, the light had been given by the Brush system, and that the magneto which had done splendid service had been replaced by others of another system, the Brush Company having declined to accept the terms proposed for the Fête de la Jeunesse. But the actual cause of the catastrophe was the nakedness of the wires used.

IN the sitting of the Paris Academy on August 21 details were given, by an observer who chanced to be on the spot, of an earthquake which was felt at Dijon on August 13. The duration of the commotion was only 1 second, a slight noise for $\frac{1}{10}$ second was heard previously. The direction of the shock was south-west to north-east. The area was only 200 metres in breadth, but it could be followed along a distance of more than 12,000 metres in length.

MR. STANFORD sends us a useful map of Lower Egypt, on the scale of 14 miles to an inch.

IN reference to our recent article on Frederic Kastner, a correspondent informs us that his father was not merely an Alsacian composer of some merit, but a learned thinker and writer whose numerous works are largely consulted in France, and which have rendered great service to the art, history, and literature of music.

THE Report of the Chief Inspector of Mines (Mr. Couchman) to the Minister of Mines for the Colony of Victoria, for the year 1881 is both an interesting and instructive document. It appears that there were altogether 38,436 miners employed in the colony, and, of these, part were engaged in alluvial mining, and part in quartz mining. The total number of accidents was 157, by which 72 men were killed and 108 injured. Forty of the deaths and 43 of the cases of injury were caused by falls of earth or rock at the surface and underground. More than 50 per cent. of the whole were thus due to a class of accidents which claim a similar proportion of the victims in our mines at home. The remaining accidents arose from: falling down shafts, winzes, and shoots; falls of material down shafts; cage accidents; machinery in motion; explosion of lithofracteur, gunpowder, dynamite, &c.; and miscellaneous causes. After describing the nature of the principal accidents Mr. Couchman discusses at considerable length the dangers due to the use of nitro-glycerine compounds, and he quotes the remarks of Lieut.-Col. Majendie upon an accident that occurred with dynamite and blasting gelatine in the Minera lead mine near Wrexham, on March 23, 1881. He also shows that the Miners' Accident Relief Funds are in a fairly healthy condition, and he says that the balance sheets which were submitted to him "afford clear proof of the great good effected by judicious combination for the relief of distress and of the large amount of benefit distributed by these praiseworthy associations since their establishment. The whole of the details of each accident, both fatal and non-fatal, are set forth in tabulated form; and five appendices show: (A) the number of accidents that occurred in the several divisions of each district; (B) the names of persons killed, whether married or single, and the number of children left by them; (C) the prosecutions under the Regulation of Mines Statute, 1877; (D) a schedule of the amounts paid to persons injured and to the relatives of persons killed; (E) the causes of the mining accidents which occurred in the several mining districts. The Report is thus very complete in every imaginable kind of detail.

THE additions to the Zoological Society's Gardens during the past week include five Wild Boars (*Sus scrofa*), European, presented by the Count de Paris; an Egyptian Cat (*Felis chaus*) from North Africa, presented by Lieutenants Fisher and Farquhar and Mr. Basset, H.M.S. *Bacchante;* a Black Rat (*Mus rattus*), British, presented by Mr. W. E. Bryant; a Thicknee (*Œdicnemus crepitans*), British, presented by Mr. C. W. Harding; an Indian Python (*Python molurus*) from India, presented by Capt. Laws; two Blue-faced Lorikeets (*Trichoglossus hæmatodes*) from Timor, received on approval.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 14.—M. Blanchard in the chair.—The following papers were read:—Note on Dr. Andries' theory of cyclones, by M. Faye. This German observer takes a similar view to M. Faye's. Cyclones, tornadoes, and *trombes* are one and the same mechanical phenomenon, and their powerful action is due to the force in upper currents. Dr. Andries furnishes experimental evidence from liquids.—On the appearance of manganese on the surface of rocks, by M. Boussingault. He found on quartz pebbles carried down by Venezuelan streams, a thin dark pellicle of bioxide of manganese. A similar coloration of granite on the Orinoco, Nile, and Congo, has been observed. The natives of the Andes say that it is only the white (colourless) rivers that produce the dark banks; they regard the black granite rocks as unhealthy (and with reason). In the Andes M. Boussingault found a spring containing a good deal of manganese, and forming deposits like those just referred to; the dark pellicle is probably due to suroxidation, in air, of the protoxide of manganesic carbonate.—Experimental researches on the mode of formation of craters of the moon, by M. Bergeron. He sends hot air through a brass tube into a melted but gradually cooling mass of Wood's Alloy. The bubbling forces the forming pellicle aside in a circular space, giving the aspect of a circus, then of a crater; ere long, the mass becoming pasty, the gas no longer clears the pellicle, but forms a cone in the middle. Some slightly different effects are had with other alloys; the sides of the cone may have a more broken-up appearance. An interruption of the current gave two concentric craters, the inner the higher (compare the lunar Copernicus, &c.).—Terms of short period in the earth's motion of rotation, by M. Rozé.—On the cure of saccharine diabetes, by M. Félizet. Bernard showed that irritation of a part of the *medulla oblongata* causes glycosuria. M. Félizet seeks to suppress irritation in the same quarter (the cause of diabetes), by the sedative action of bromide of potassium, and in fifteen cases he has thus effected a cure.—On a new process of insulation of electric wires, by M. Geoffroy. He wraps them in asbestos fibres and encloses in a lead tube. The wire may be quite volatilised without a spark being emitted. The lead shows no trace of fusion.—Discovery of a small planet at Paris Observatory, by M. Paul Henry.—Description of the Manger Præsepe in the Crab, and micrometric measures of relative positions of the principal stars composing it, by M. Wolf. — On the theory of uniform functions of a varible, by M. Mittag-Leffler. — General method for solution of problems relative to principal axes and moments of inertia; oscillation balance for estimation of moments of inertia, by M. Brassinne.—On the longitudinal vibrations of elastic bars, &c. (continued), by MM. Sébert and Hugoniot.—Hydrodynamic experiments; imitation by liquid or gaseous currents, of magnetic figures obtained with electric currents or with magnets (sixth note), by M. Decharme. *Inter alia*, water or air is forced through a tapered glass tube against a plate covered with a thin layer of minium diluted with water.—On the surface tension of some liquids in contact with carbonic acid, by M. Wroblewski. The decrease of the superficial tension of the liquids depends solely on the fact that the superficial tension of the carbonic acid with which they are compressed is extremely small.—On some arseniates neutral to litmus, by MM. Filhol and Senderens.—Fermentation of starch; presence of a vibrion in the germinating grain of maize and in the stem of this plant, by M. Marcano. This inquiry relates to *chicha*, a strongly alcoholic drink prepared by American Indians from maize. The vibrion's presence is regarded as clearing up several points hitherto obscure.—On five new parasitic protozoa, by M. Künstler. These were found in the larva of *Melolonthus* and of *Oryctes*, and in tadpoles.—Researches on the organs of flight in insects of the order of Hemiptera, by M. Moleyre. The apparatus connecting the anterior and posterior wings is here studied; M. Moleyre considers that in the sub-order Heteroptera, whose hemelytra (or anterior wings) fulfil best the *rôle* of protective sheaths, the connecting apparatus appears, with a remarkable fixity, in its most perfect form.—Pierre Breton and the binary nomenclature, by M. Crié.—On a disease of beet, by M. Prillieux. This disease, unknown in France before, and due to a *Peronospora*, has appeared at Joinville-le Pont (Seine) —On the coal of Muaraze, in Zambesia, by M. Guyot. "Exploitation" seems impossible.

CONTENTS

THURSDAY, AUGUST 31, 1882

THE LITERATURE OF BOTANY

Guide to the Literature of Botany. Being a Classified Selection of Botanical Works, including nearly 6000 titles not given in Pritzel's "Thesaurus." By Benjamin Daydon Jackson, Secretary to the Linnean Society. Pp. xl. 626. (London: published for the Index Society by Longmans, Green and Co., and Dulau and Co., 1881.)

Vegetable Technology. A Contribution towards a Bibliography of Economic Botany, with a comprehensive Subject index. Pp. xii., 355. (Same Author and Publishers, 1882.)

WE have here two books of unequal importance which nevertheless have so much in common that they may fitly be noticed together. Both are produced by the same author, and under the auspices of the same Society—a Society, by the way, which has not escaped severe criticism of the *cui bono* order, but which goes far towards justifying its *raison d'être* by the publication of works like those now to be considered. The "Guide to the Literature of Botany" was issued about a year since, but has not been noticed in these pages; so that the appearance of the later work furnishes an opportunity for some reference to the former.

We have referred to the two volumes as unequal in importance—seeing that one offers itself as a guide to the whole of botanical literature, while the other only occupies a small portion of the same wide field. But the inference that "Vegetable Technology" was merely a portion of the larger work would be very incorrect; the two volumes are quite distinct, and are treated in a different manner, and neither covers the ground occupied by the other. The arrangement of the two books is also different. The "Guide" is a list of books classified under headings expressing different branches of the subject, the index consisting of the authors' names, with reference to the titles (abbreviated) of their works. By the time Mr. Jackson had completed the "Guide," he was fully conscious of the inconveniences of this plan; and formed a resolution that, if again engaged in any similar labour, he "would steadily adhere to the practice of ranging the works under an alphabetical sequence of authors' names"; this resolution he has carried out in "Vegetable Technology." There can, we think, be little doubt as to the advantage of this latter plan. It is by no means easy to classify some works; and Mr. Jackson's grouping in his earlier volume, although at least as good as could have been expected, is sometimes not quite satisfactory. One does not quite know what to expect under such headings as "Maturization" (p. 101), "What is a Species?" (p. 97), or "Sundry Phenomena" (p. 107). A reader searching for references to works on the bamboos would find one such treatise under *Bambusa;* but he would hardly think of searching further under the heading "Textile Plants," where, nevertheless, is a second book on the subject, "Bamboo and its Uses," by S. Kurz. A cross reference here, as in many other cases, is almost essential; on the system adopted in "Vegetable Technology," a help of this kind is supplied by the index of subjects. The island of St. Croix is not in Oceania (p. 404), but in the West Indies. Ellis's "Directions for bringing over Seeds" would be better under "Plant-collection" (p. 217) than under "Botanical Gardens" (p. 405); Crépin's "Guide du Botaniste," if placed among "local Floras," should certainly be also referred to under the first-named heading; Lemaire's *Flore des Serres* has so much in common with the *Botanical Magazine*, that it seems strange to find the former under "Botanical Gardens" (p. 406) and the latter under "Serial Publications" (p. 473). Criticisms of this kind might, if needed, be almost indefinitely extended; but probably enough has been said to show that a classified list is open to considerable objections, of which, as has been already shown, the author himself is fully aware.

VOL. XXVI.—NO. 670

We have alluded to cases in which a cross-reference would have been of great use; this is very noticeable in the section devoted to "Monographs." Under *Compositæ*, for example, only two memoirs are noted; but in the same section are at least twenty papers or treatises devoted to plants belonging to the same order. There are four entries under *Solanaceæ;* references to *Capsicum*, *Datura*, and *Nicotiana* would have been useful.

But allowing that there are matters of detail which might have been improved, there cannot be two opinions as to the great value of Mr. Jackson's work. The mere fact that it includes "nearly 6000 titles not given in Pritzel's 'Thesaurus'" testifies not only to its usefulness, but to the industry of its compiler in hunting up omissions; for although many of the works have been issued since the publication of the "Thesaurus" (1871), the proportion of treatises omitted from that invaluable work is very considerable. There may be some who regret that Mr. Jackson did not give us a new edition of Pritzel while his hand was in; but as he tells us that "the Guide is meant to be SUGGESTIVE, not EXHAUSTIVE," we have no right to complain that he does not give more than he intended; and indeed the general feeling will be one of satisfaction that he has given us so much.

In the preface to his second volume Mr. Jackson tells us that "a complete bibliography of Economic Botany would need the labour of years;" and this seems at least probable if we accept his previous statement that "the bibliography of the vine in all its bearings would require a lifetime for its compilation." As we hope to have much more good work from Mr. Jackson—notably the new edition of Steudel's "Nomenclator," upon which vast undertaking he is now, with characteristic energy, engaged—we do not blame him for putting the exacting vine on one side. Besides independent works, "Vegetable Technology" includes the titles of papers in the *Journal of the Society of Arts* and the *Pharmaceutical Journal*, with some from the *Journal of Applied Science*, and the *Technologist.* We could have wished that the many excellent papers in the various botanical journals edited by Sir W. J. Hooker,[1] as well as others published in the *Journal of Botany* during recent years had been included: the *Gardeners' Chronicle*, too, is only quoted at second-hand, when papers have found their way from its pages into those of the *Pharmaceutical Journal.* In many cases Mr. Jackson has added the scientific name of

---

[1] It is much to be regretted that there is no index worthy of the name to any of these journals, which contain a vast amount of useful matter. Will the Index Society at some later date place botanists under still further obligations to them by undertaking this work?

the plant under discussion, and this is very useful; not every one knows off-hand that "Kafurkachri" = *Hedychium spicatum*, or that "l'inée" = *Strophanthus hispidus*. Of course these are omissions we do not find in Mr. Kurz's book on the Bamboo, mentioned above; the volume on the "Eatable Funguses of Great Britain," illustrated by Mr. W. G. Smith, is not referred to, although Mr. Badham's "Esculent Mushrooms" is mentioned; while on the other hand such books as Loudon's "Hortus Britannicus" seem hardly to deserve a place. The Index, to which reference has already been made, is all that an index should be, and fully justifies Mr. Jackson's belief that "these entries supply a very fair starting-point for almost every question in vegetable technology."

Space will not allow us to enter further upon the merits of these Guides. Enough has, however, been said to direct attention to their importance and practical utility, and to encourage the happiest auguries for the success of the *magnum opus* upon which Mr. Jackson is at present engaged.

JAMES BRITTEN

OUR BOOK SHELF

Talks about Science. By the late Thomas Dunman. (London: Griffith and Farran.)

UNDER an unpretending title are here collected a number of lectures that were delivered to popular audiences, chiefly in and about London, by one whose decease, recently, in the early prime of life, has been much deplored. At the time of his death, Mr. Dunman held a post of tuition in Physiology and Animal Morphology in the Birkbeck Institution, and his labours there and elsewhere were attended with growing popularity and success. The biographical sketch by his friend, Mr. Charles Welsh, with which the book opens, tells of the zeal and well-directed energy with which he applied himself to overcoming the obstacles that for some time barred his path to what he considered his true life-work, viz. the teaching of science. These lectures—thirteen in number, deal with a considerable variety of topics, the mechanism of sensation, the star-lit sky, prehistoric man, volcanoes and coral reefs, atoms and molecules, and so on. The style is terse and lucid, and appears to have been carefully formed on the best models. The happy gift of relieving the strain of which many minds are conscious under mere scientific exposition, by some passing allusion to a familiar human experience, by the homely figure, the apt quotation, the play of imagination and humour, Mr. Dunman seems to have possessed in rich measure.

The lectures entitled "Two Life Histories" and "How the Earth is Weighed and Measured," may be taken as good examples of abstruse matters expounded without technical language, and made clear for a working-class audience. Mr. Dunman's going down a coal-pit in order to qualify himself more thoroughly for his lecture on "Coal," is typical of much of his work, which in this respect (the "testifying that which he had seen") manifested, no doubt, the inspiration of his admired teacher, Huxley. Exception might be taken to a few passages in the lectures, *e.g.* to the account of ocean temperatures, in "Depths of Ocean" which seems inadequate; and occasionally the author seems to affirm more confidently than the facts warrant. But as a whole the book is a good specimen of sound popularised science, and eminently engaging. As a present to a young artizan with a nascent love of science, it could not fail to be much appreciated.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The "Eira" Arctic Expedition

I AM confident that the anticipation, contained in your article on Mr. Leigh Smith's expedition (p. 387), that he has been able to make some addition to our knowledge of geography, has been realised.

The object of Mr. Leigh Smith's voyage was a reconnaissance to accumulate evidence respecting the advantages offered by Franz Josef Land as a base of operations for future exploration. He did not intend to winter; but the accident which forced him to do so had the useful result of enabling him to extend his valuable observations over two seasons. The knowledge he thus acquired of the movements of ice, of its character along the shores and in the fiords for sledging purposes, of the prevailing winds and currents, of the amount of animal life to be obtained in the different months, will be very useful. This knowledge will be welcomed by the geographical student, and will also be of great value to future explorers. The loss of natural history collections is to be regretted, but the main object of Arctic exploration is geographical, and that object has been fully secured.

The crew of the *Eira* passed through the winter in perfect health. Yet they had no lime juice and, from want of warm clothing, comparatively little exercise during the coldest period. This fact must modify the theories based on the report of the Scurvy Committee. Here we have additional proof that it is fresh meat, and not lime juice, which is the chief preservative of health.

Another interesting point which the cruise of the *Eira* will throw further light upon, is the direction from which the ice-bearing currents come. In a former letter I called attention to the evidence of Sir Edward Parry on this point, and to the fact that his conclusions had been corroborated by subsequent observation. Mr. Leigh Smith's voyage will furnish additional evidence upon this geographical question. As regards the advantages of Franz Josef Land as a base for future discovery, Mr. Leigh Smith has shown that in 1881 and in 1882 that land could easily be reached; so that we now have proof that in five consecutive years Franz Josef Land was accessible, that it has suitable bays for winter quarters, that the shore-ice in the fiords offers good sledging surface, and that there is abundance of animal life. Mr. Leigh Smith's voyage will be found to have been most useful to geographical science, and fully to have secured the object of a reconnaissance, for which it was undertaken.

CLEMENTS R. MARKHAM

21, Eccleston Square, S.W., August 28

Markree Magnetic Dip

I HAVE made the following determinations of the magnetic dip by aid of one of Dover's excellent Kew-pattern dip-circles (No. 67). As I am observing on a pier in the open air I am not able to always use both needles simultaneously. On August 1 I observed within a few feet of the wall of the meridian-room. The other observations were made at a distance of over 100 feet from any wall:—

Date.	Time. h. m.	Dip. ° ′ ″	Needle.
1882 August 1	1 47 p.m.	[70 26 50]	No. 2
,, 2	4 2 ,,	27 38	,, 2
,,	5 2 ,,	25 16	,, 1
,, 3	2 50 ,,	26 27	,, 1
,,	3 56 ,,	27 37	,, 2
,, 15	5 22 ,,	26 8	,, 1
,, 16	3 32 ,,	26 58	,, 2
,, 21	1 37 ,,	25 37	,, 1
,,	3 0 ,,	25 1	,, 2

Prof. Lloyd determined the magnetic dip at this place forty-seven years ago on the same date as follows:—

1835, August 21 ... 2h. 22m. 72° 4′ 48″.

Comparing this with the dip 70° 25′ 19″ to day, I find for the annual decrease, 2′·117.

W. DOBERCK

Markree Observatory, August 21

The Gesture Speech of Man

The valuable paper of Col. Mallery (NATURE, vol. xxvi. p. 333) is deserving of much attention, but his description of the relations of gesture-language and speech-language is calculated to cause misconceptions, on account of the view he has taken of the origin and propagation of speech. Admitting the general accuracy of his description of the gesture-language or dialects of man, then that description is really applicable to speech.

Setting aside all theories and looking at facts, all spoken languages have psychological relations, as gesture-languages have, and in their early stages are founded on the same principles of having several representations for one idea, and several ideas for one representative sign. With regard to sounds applied as representative signs, as a general law these are the same for all languages, and the diversity observable arises from the diversity of selection and distribution.

It can be seen by the commonest observer that among the remotest languages there are like words, but as it is assumed they cannot be related, these identities are put down to chance and disregarded. On the other hand, many are led astray by such identities to set up relationships and to form schemes of classification between languages, which are not justly admissible. Nothing has been more ridiculed than the identities of words set forth between Quichua, for instance, and various languages of the old world, and yet nothing can be more just than the identities, which speak for themselves to the unprejudiced.

A great argument against the relationship of languages has, on the other hand, been derived from the diversities which are equally apparent as the identities among such languages, and the supposed negative evidence derived is used as conclusive against any relationship.

The phenomena are very complicated, as are the phenomena of gesture-language, but the solution is to be found in those remarks of Mr. A. R. Wallace, of which I have given the application as the Wallace formula (NATURE, vol. xxiv. pp. 244, 380). I repeat this, because further observations and a long course of investigation leave no doubt as to the facts and their application.

Proceeding on the basis of a system of sign-languages generally existing in the world, we obtain the explanation of the engrafting of sounds in defined series. Mr. Wallace's labial for mouth, nasal for nose, and dental for tooth, provides labials for every idea based on the round form of mouth, or on its opening and closing, as head, face, eye, ear, sun, moon, egg, &c. These, again, were in relation with defined mythological and numeral characteristics, affording abstractions.

Thus, a whole apparatus of speech was provided, but it was complicated first by the condition, imparted from gesture language of plurality of signs, and next by the faculty of applying various labials, &c. What Col. Mallery states to have taken place in gesture language is precisely that which took place in speech language. In the process of selection, the apparatus of each class was ultimately diminished so far as the common stock was concerned, and each language acquiring only a portion of the common stock, has at present the appearance of a separate and indiscriminate vocabulary in relation with all, but not identical with any except its own immediate congeners.

Thus the effective comparative philology of any language ultimately depends on its relationship to all, and not to one family.

As all speech languages are of common origin, so we must admit a common diffusion of them over the world. The result is seen in the relationships of the languages of America with those of Africa, for instance, but it is attested by a community of verbal forms in traditions and in mythylogy, and even in geographical nomenclature. It is the traditions of this diffusion of speech which underlies many of the deluge legends.

The epoch of this diffusion is sufficiently clear, for the words widely distributed show that it was in an epoch of considerable culture.

Col. Mallery accurately states that there is a relationship between the gesture languages and some of the ancient characters, and this supposes that characters may have co-existed with gesture before the diffusion of spoken languages. Admitting this, we have to regard not only the relations between gesture and speech languages, but between the characters and speech and the manner in which characters were applied to the spoken languages, and modified by them.

Among my later investigations have been those relating to the applications of Mr. Wallace's formula to characters, syllabaries, and alphabets. It may be remembered that one means by which I was enabled to apply Mr. Wallace's remark was by means of previous observations on the ○ and + series in the Chinese and other ancient characters. Speaking concisely we have for labials ○, (□), ⊙, ☾, ʘ, ϕ, &c.; for nasals (which are male) +, ×, ⊤, ÷, Ꞥ, N, ʌ, &c; for dentals, ∧, △, ↑, &c.

If we examine a syllabary or alphabet, more particularly one of ancient form, then we shall generally find that the labials, &c., conform They are, however, besides translations of the original word, subject to interference, because where the general idea involves a labial, the labial may have been excluded by a dental. Doorway is a labial, but door, as in English, a dental, doorway being taken from the mouth, and the door from the teeth within, and although the words are distinct in many languages, yet in some one only has survived. The character for mountain, country, &c., is tooth, △ or △△△, but other relations for mountain are navel, drum.

In its application for the examination of characters this Wallace formula is very useful. Thus the Korean conforms to it, and the Vy or Vy, supposed to be modern, conforms to a test of antiquity.

Nothing can be more true than Col. Mallery's description of the rapidity of gesture-language. Any one who observes the mutes of the Seraglio at Constantinople, who in my opinion transmit the system of the ancient pantomimes, will at once perceive how quickly thought is portrayed under conventional representations. Much of their conversation is naturally on political topics, and they have not only signs for each individual, but it is reputed for each city of the empire, as they undoubtedly have for foreign countries. Incidentally I may mention that they apply lip-reading for giving names, as in all probability they have for centuries.

Col. Mallery supposes that gesture-language in its present shape originated spontaneously and sporadically, but in legend there is the suggestion of a diffusion of gesture-language, as of speech. Thus we have two epochs in tradition, that of creation, and that of the propagation of speech, which appears under the form of the deluge traditions. Some interesting illustrations of the whole matter will be found in Mr. Man's monograph of the Andamanese, now being published by the Anthropological Institute.

With the great advantages of gesture-languages, Col. Mallery has not explained how they have succumbed to speech-language, nor is his suggestion of their value as a common language among spoken dialects adequate. Where a speech-language becomes a common language it also extirpates the sign-languages, and a great language swallows up the numerous smaller brood. Europe was at one time as thick with languages as North America or Africa, and now a few of one family dominate.

32, St. George's Square, S.W.

HYDE CLARKE

Orange Culture in Florida

IN reply to the inquiry in your columns regarding orange culture in Florida, I venture to recommend an agreeably written account of that State, entitled "Florida: for Tourists, Invalids, and Settlers; containing Practical Information regarding Climate, Soil, and Productions; Cities, Towns, and People; the Culture of the Orange, and other Tropical Fruits; Farming and Gardening; Scenery and Resorts; Sport; Routes of Travel, &c.," by G. M. Barbour (New York: Appleton and Co., 1882.) I had this volume in hand during a stay of a few days in Florida last May, and found it, so far as I could judge, fully entitled to the "Testimonial" from the State officials which graces its opening pages. It has a chapter, of thirteen pages, devoted especially to "Orange-culture," besides constant references throughout its pages to this branch of the rising industry and development of that delightful sub-tropical region. In the same chapter there is a note as follows: "Much the best work on the subject is Rev. T. W. Moore's 'Treatise and Handbook on Orange Culture in Florida,' of which a new revised and enlarged edition has just been published by E. R. Pelton and Co., 25, Bond Street, New York." Mention also occurs of a "Guide to Orange Culture" by "the Manville Brothers"—but I do not find a more precise indication.

J. HERSCHEL

Collingwood, August 26

WILLIAM STANLEY JEVONS

WILLIAM STANLEY JEVONS, whose tragical death was recorded in our issue of the 17th inst., (p. 377), was born at Liverpool in 1835. As in the case of most men of intellectual work, the facts of his life are few and simple. He was educated partly in Liverpool, partly at University College, London, where he particularly distinguished himself in the classes of mathematics and natural science. For University College Jevons ever retained feelings of the warmest loyalty. He was proud of his connection with it and with the London University, and doubtless these feelings weighed with him when in 1876 he resigned his chair at the Owens College and accepted that of Political Economy at University College. Before completing his career as a student, Jevons accepted an appointment in the Sydney Mint and spent five years (1854-59) in practical work abroad. At the close of that time his disinterested determination to devote his life and energies to intellectual work of the highest kind prompted him to return to England and to resume his interrupted studies. He graduated at London in 1862 with the highest distinction in logic and political economy, and a year later began his active career as a teacher in the capacity of general teacher at the Owens College, a post he occupied for three years. Even at this early period of his life, however, he had already produced not only an earnest of his great powers but the germs of all the best work he afterwards accomplished. A pamphlet on the *Fall in the Value of Gold*, and an important work on the probability and consequences of the exhaustion of coal sufficiently attested his mastery over concrete problems of economics. But of even greater significance was the short paper presented in 1862 to the British Association on quantitative reasoning in economical theory and the little noticed volume on *Pure Logic* (1864). The one contains the fundamental notions of the author's later work in theoretical political economy, the other the first principles and outlines of the development of his well-known symbolical logic. In 1866 Jevons was appointed to the combined chair of Philosophy and Political Economy at the Owens College, and for ten years he discharged with the greatest ability and success the onerous duties of the office. During this time his practical activity was incessant and his intellectual labour continuous. In political economy his occasional contributions in the shape of papers in the *Statistical Society's Journal*, addresses or reviews, his important treatise, the *Theory of Political Economy* (1871), and his excellent manual on logic, his tract *Money; or, The Substitution of Similars*, his *Elementary Lessons on Logic*, and his great work, the *Principles of Science* (1874), raised his reputation to the highest point, and it may be confidently said that no man ever obtained or deserved so thoroughly to obtain more widespread recognition as a master in these departments of knowledge. In 1876 the feeling that his time might with greater advantage to himself and the public be devoted to continuing his original researches, prompted his resignation of the laborious chair at Owens College. In that year he migrated to London and to University College, and for five years he continued to hold the chair of Political Economy in that institution. The same desire for more time induced him in 1881 to resign the comparatively light duties of his London chair, and he was doubtless enjoying the feeling of perfect freedom to devote himself to his beloved work when the abhorred shears cut short the thin spun thread of his life. A great force for good and a noble type of the man of science has been lost to us in Jevons.

The feature which perhaps impresses one most in reviewing the products of so busy a life, apart altogether from the fine and most lovable character of the man, is the combination of multifarious interests with uncommon tenacity in working out certain definite lines of thought. It is a feature peculiar to what is called genius and its presence, even when in less than a pre-eminent degree stamps the mind, exhibiting it as one of the highest order. Jevons's scientific training was excellent, his knowledge of the details of scientific work in many diverse branches truly universal, his interest in scientific questions and his love of scientific research of the keenest. A full record of the many contributions made by him to the great dictionary for the library of Chemistry and Philosophical Society in Manchester, to the *Philosophical Magazine*, and to our columns, it is hardly possible yet to produce, but it may be said that the character of his work, whether it be upon gold assaying, upon the forms of clouds, upon the motion of minute particles in liquids (a phenomenon named by him *pedesis* and examined with long continued and loving care), or upon the connection of sun-spot periods with economic changes, is such as to prove him amply endowed with the finest qualities of the investigator of nature. Indeed there can be little doubt that had Jevons devoted himself to physical inquiry he had all the ability to secure a reputation possibly not inferior to that gained by him in other departments. He was an *exact* thinker, in the best sense of that term, and brought to bear upon great and economical problems a power of methodical, patient reflection comparable with that displayed by any of his contemporaries in the field of physical research.

In logic and political economy his numerous and varied writings have secured him a very distinct place in the first rank of writers. In both subjects he united, to a quite unusual extent, wide and comprehensive knowledge of details, with rare originality in handling scientific principles. His treatment of questions of detail, apart from his original contributions to the theory of either subject, would alone have secured for him a high reputation. Thus the *Principles of Science* contains a most exhaustive and penetrating analysis of the methods of scientific work, illustrated from all branches of scientific research with a fulness and precision that leave little to be desired, while his various works and papers on economic and social problems, in the treatment of which he exhibited a most happy talent of effective exposition, constitute a contribution of very high value to the literature of political economy.

The permanence of his fame as a writer of the first order in his special subjects, however, must naturally depend upon the character and value of his original researches in the first principles of logic and political economy. As was above said these researches occupied Jevons throughout the whole of his active career as a writer, and his successive works are but the amplification and development of thoughts which had presented themselves to his mind at a very early period of his life. In political economy this thought was the reference of the laws of complex phenomena, such as prices, interest, and so on, to the simpler laws of pleasurable and painful feeling, the subjection of their simpler laws to quantitative treatment and the consequent application of exact, even of mathematical, methods to economics. He was too far-seeing and too judicious to overlook the enormous gulf that separates abstract economics from the domain of practice, and he was under no delusion as to the practicability of applying exact methods to phenomena so immensely complex as those of society, but within the domain of abstract theory he perceived the need for some more vigorous method than that usually employed, and his contribution is of rare value. Here indeed, as in logic, Jevons had to suffer a fate common to thinkers of undoubted originality, that of discovering that their new principles and new methods are not absolutely new. But in either science, it may be safely said that if Jevons's contributions cannot claim novelty, they can always claim originality in the honest sense. They were thoroughly his own and were developed by him with ingenuity and exhaustiveness such as amply to establish his title to them. No man, it may be added, was ever more anxious than Jevons to do justice to the labours of his predecessors, and he was ever ready to welcome in the most generous fashion any indication of an anticipation of some favourite thought. His work was good enough, and he knew it was good enough, to stand upon its own merits.

In logic the system of formal or mechanical reference which Jevons worked out in great detail, was founded upon the antecedent researches of Boole. The processes, however, were presented by Jevons in such a fashion, the principles were so simplified and the capabilities of the method so ingeniously developed that his work has a secure place of its own alongside that of Boole. This is not the place for discussing the permanent worth of the new analysis of inference, but it may be said that hardly sufficient justice has yet been done to many of the speculations into which Jevons was naturally led in the development of his analysis. His treatment of the relations of logical and numerical quantity, and his attempt to deal with induction apart from all quasi metaphysical principles are bold and subtle contributions to logical theory and, in connection with his other work in this department they sufficiently establish his place as an original and thoughtful logician.

For philosophical speculation, in the wider sense, Jevons had little inclination, and possibly from the character of his intellect, little ability. Dealing with ultimate logical and economical questions he was often driven to the verge of inquiries such as fall under the designation of philosophy, to problems of the theory of knowledge and of ethics, but he never crossed the boundary, and indeed seemed somewhat impatient of the existence of a land beyond the formal relations of logical terms or the quantitative variations of pleasure and pain. This lack of interest in problems going to the root of logical and economical theory makes itself apparent in almost all his works, and probably, for many reasons, deprives them of some of their value. It is impossible to say, however, what genuine contribution to English philosophising might not heve been made had so original and well endowed a mind been spared longer to us.

THE BRITISH ASSOCIATION

ALTHOUGH the numbers at the Southampton meeting have little exceeded 1200, still so far as the essential work of the Association is concerned, it has been up to a fair average. The New Forest excursion was an especially enjoyable one, though that to the Isle of Wight was most interesting from a scientific point of view.

During the meeting the reception rooms and the rooms in which the Sections have met have been connected by telephones. In each room was a board on which were painted in a line the letters indicating the Sections. Below each letter there was space for a figure to be inserted to indicate the number of the paper in the day's programme that was under discussion; if it were No. 3 in Geology, the attendant there sent the number to the reception room. Here the attendant marked the board, and then sent the information to all the other Sections, so that it could be known in all the rooms what was the subject under discussion in each Section.

There was a sharp discussion on the question whether the Association should meet in Canada next year, seeing that Oxford has withdrawn its invitation, but the meeting decided on Southport, with Prof. Cayley as President. Canada (Montreal) was, however, selected for 1884.

There is a very strong feeling that the vote of the General Committee binding the Association to go to Canada in 1884, was not a representative one. The first vote taken was adverse to crossing the Atlantic, though it was felt that if this were done it would be specially desirable to do so while the Marquis of Lorne is President, as he has done much in founding the most important scientific institutions in Canada, and his tenure of office terminates next year. When Southport gained the majority the larger number of the Committee left the room, not being aware that the place of meeting for the following year, 1884, was going also to be determined, and the supporters of the Canada invitation, led by an able tactician, Capt. Bedford Pim, secured an easy victory. It is worthy of note that the Members of the General Committee, who contributed to this result, with few exceptions, did not include Presidents and Secretaries of Sections, or indeed many of the working members of the Association, and it is therefore greatly feared that should the proposed visit be made, the meeting will not be a representative one.

It is satisfactory to learn that the Council are taking steps to learn the real wishes of the Members, by asking every Sectional Committee to send up three or four representatives to constitute a committee to confer with the Council as to the means of carrying out the proposal, if found to be feasible. It is worthy of note that previous to the meeting at Southampton, the Council sent out a notice to the whole of the General Committee, inquiring their views on the subject, and that the replies obtained from a far larger portion of the Committee than that attending the meeting was distinctly adverse to leaving the British Isles. It was felt that the proposed departure would be unfair to Life Members, who had purchased a right to attend meetings in that area, and would prevent the greater number of sectional officers and working members from attending, their movements being controlled by considerations of time and expense.

The following is the list of grants voted for next year:—

A—Mathematics and Physics

Scott, Mr. R. H.—Synoptic Chart of Indian Ocean ...	£50
Darwin, Mr. G. H.—Harmonic Analysis of Tidal Observations	50
Brown, Crum—Meteorological Observations on Ben Nevis	50

B—Chemistry

Tilden, Prof. W. A.—Investigating Isometric Naphthalene Derivatives	15
Odling, Prof.—Photographing the Ultra-Violet Spark Spectra	20
Pye-Smith, Dr.—Elimination of Nitrogen	30

C—Geology

Etheridge, Mr. R.—Earthquake Phenomena of Japan ...	50
Williamson, Prof. W. C.—Fossil Plants of Halifax... ...	20
Sorby, Dr. H. C.—British Fossil Polyzoa	10
Etheridge, Mr. R.—Fossil Phyllopoda of the Palæozoic Rocks	25
Hawkshaw, Sir John—Erosion of the Sea Coasts of England and Wales	10
Hull, Prof. E.—Circulation of Underground Waters ...	15
Evans, Dr. J.—Geological Record	50
Ball, Prof. V.—Carboniferous Limestone Caves in the South of Ireland	20
Etheridge, Mr. R.—Llandovery Rocks of Central Wales ...	10

D—Biology

Pitt-Rivers, General—Photographs of the Races and principal Crosses in the British Isles	10
Stainton, Mr.—Record of Zoological Literature	100
Cordeaux, Mr. J.—Migration of Birds	20
Lankester, Prof. Ray—Table at the Zoological Station at Naples	80
Pye-Smith, Dr.—Scottish Zoological Stations	25
Hooker, Sir J.—Exploring Kilimandjaro and the adjoining Mountains of Eastern Equatorial Africa	500
Meldola, Mr. R.—Investigation of Loughton Camp ...	10
Sclater, Mr. P. L.—Natural History of Timor-Laut ...	50

G—Mechanics

Bramwell, Sir F. J.—Relation between the Pressure at different Points of a Structure on which Water and Air impinge	£25
Whitworth, Sir Joseph—Screw Gauges	20
Bramwell, Sir F. J.—Patent Legislation	5

SECTION C

GEOLOGY

OPENING ADDRESS BY ROBERT ETHERIDGE, F.R.S., F.G.S., PRESIDENT OF THE SECTION.

FOR some years it has been the rule or practice that the Presidents should open the sectional meetings with an address, selecting any subject which may seem to them best adapted to the occasion. This custom I believe had its origin in this Section, when the Association met at Aberdeen, and was due to Sir C. Lyell, who was the first to deliver an opening address. He selected for his theme the discoveries of M. Boucher de Perthes, chiefly with relation to the occurrence and association of flint weapons with the bones of extinct animals in the gravels of the valley of the Somme.

The Geological Section, over which during the present meeting I have the honour to preside, embraces a wide field of research, and therefore allows selection from a large range of subjects, so large indeed that it would be difficult to choose an original one that would be acceptable and useful to those members of the Association who may be present. It is thirty-six years since the British Association last met in Southampton, and probably not half-a-dozen members who attended the meeting of 1846 are now present, if living. We are, however, fortunate in having with us to-day one or two who contributed papers to this Section thirty-six years ago.

The Geological Section may be congratulated on its place of meeting this year. Hampshire presents a wide range and field of research to the practical, as well as the less advanced student in geology. Truly may it be said that this area is classic ground. No less than six distinct formations, with their subdivisions, occur in the immediate neighbourhood and within reach of those members who have honoured the Association with their presence this year. Be it remembered that it is thirty-six years since the British Association met in this city. Since then, or the year 1846, geology has indeed advanced with strides unsurpassed by any other science. The Tertiary rocks of the Hampshire basin alone have received from the hands of private and learned physicists, as well as the long-continued labour of the Geological Survey, the most careful and detailed research. It may well be said that this rich field has not wanted competent labourers, earliest and foremost of whom must be named Webster, Sedgwick, Prestwich, and Edward Forbes, who with Mr. Bristow mapped out with so much care and accuracy the intricate structure of the Isle of Wight. To these must be added, through later research, the names of Searles Wood, Wright, Fisher, Tawney, Keeping, Judd, and others. Other portions of Hampshire and Sussex bearing upon the question of the Anglo-French Tertiary basin, have been elaborately treated upon by Dixon, Godwin-Austen, Sir C. Lyell, and others.

It may be a fitting preliminary to local communication which will most probably come in, during the course of this meeting, that I should summarise what has been done in this area. This may be familiar to many, but there are others who may wish to examine certain geological localities, the mention of which may induce them to visit spots of much interest. It is scarcely the duty of the president of this Section to devote the time allowed to an opening address to the discussion of any original subject, while work of unusual local interest has transpired during the past year to justify him in drawing attention to a subject of much importance connected with the stratigraphical position of certain beds in the Eocene strata of the Isle of Wight; a question of local geologist interest, as well as bearing upon the correlation of the Tertiary rocks of Hampshire with those of France, Belgium, and Germany. Instead, therefore, of offering to the Geological Section an address on some special subject or branch of general geology, I have deemed it more interesting, and certainly more useful, to lay before you an outline of certain physical features occurring within the immediate neighbourhood, and district in which we are now assembled.

I purpose therefore to call attention to the local geology of this area, especially as regards the Tertiary deposits of Hampshire and Sussex, as forming or constituting the northern portion of a vast series of deposits once continuous to Northern France, the area now covered by the English Channel and the Solent, and lying in the depression of jurassic and cretaceous series. The relation also of the Hampshire and Anglo-French basin and its tertiary fauna to that of the London or Anglo-Belgian area will receive notice, as being part of the history of one great period, the strata comprising the two areas being also once continuous, much of it being subsequently removed or denuded away from those areas now occupied by the English Channel and German Ocean.

Before especially noticing the Isle of Wight and the neighbouring coasts, I must state that by laborious search over both old and new ground, and through the very careful examination of collected specimens during the past twenty years, great light has been thrown on the geological structure of many local areas hitherto obscure from want of critical palæontological knowledge being brought to bear upon the fossil fauna or flora characterising the various marine and freshwater deposits with which the surrounding district abounds. Greater precision has of late been arrived at in the chronological arrangement of the cretaceous and tertiary strata which occur both in the Isle of Wight and on the mainland.

Doubtless you are all aware that the strictest investigation as to the distribution and organic contents of the Fluvio-marine Tertiaries of the Isle of Wight, was undertaken by Professor Edward Forbes, when attached to the Geological Survey from the years 1848-56, and subsequently Mr. H. W. Bristow, F.R.S. completed all the older tertiaries and cretaceous rocks of the island, thus producing a complete geological guide to this portion of the Hampshire basin. The structure of the opposite coast to the east, or that embracing Bracklesham Bay, Selsea, and Bognor, was critically treated by Mr. Frederick Dixon in the year 1850, ("The Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex." By F. Dixon, 1850, 1st ed., 2nd ed 18.) who was most ably assisted in his palæontological researches by the most distinguished naturalists then living, each faunal group receiving critical supervision and description. A second edition of this valuable work appeared in 1878, wherein much new geological and palæontological matter is added; both the Cretaceous and Tertiary reptiles were figured and described by Professors Owen and Bell, the fishes by Sir Philip Egerton, the Cretaceous echinodermata, by Professor Forbes. Mr. Sowerby described the mollusca, and the large crustacea were described by Professor Bell, and the corals by Lonsdale.

SELSEA.

I now draw your attention to a locality of extreme interest both to the geologist and archæologist, and where cause and effect are manifested in both investigations, the historical portion being based upon physical causes and changes that have long been, and are still going on, to modify the form, extent, and structure of the Sussex coast, from the mouth of Chichester Harbour to Littlehampton and Bognor. In the year 1855 Mr. Robert Godwin-Austen, F.R.S. and G.S., read before the Geological Society an elaborate paper upon the "Newer Tertiary Deposits of the Sussex Coast," in which he also noticed some peculiar features in the parts of the Isle of Wight and South Hants bordering the Solent.

From Beachy Head to Selsea Bill, the coast line lies east and west, so that there intervenes a tract between the chalk range and the sea which ultimately acquires a width of ten miles, as from Lavant to Selsea. This tract is low and level, presenting a series of superficial accumulations, remnants of a definite Tertiary period, of which at no other place in England is there any such record, and to which I ask your attention should any journey to inspect the phenomena exposed along the shore of Bracklesham Bay, or between Wittering and Pagham Harbour, or Bognor be proposed. Especially may I refer to interesting evidence as to local conditions during the glacial period. It may not be known to many, or all present, that the peninsula of Selsea is celebrated in English history as one of the places where Christianity was first taught in this country. It was one of the most ancient Saxon establishments. This peninsula was granted by Edilwalch, King of the South Saxons, to Wilfred the exiled Bishop of York, about the year 680. At that time it is stated to have contained 5,220 acres of land, with 85 families and 250 slaves. The parish now contains only 2,880 acres; 2,340 having been slowly denuded away by the action and encroachment of the sea. This encroachment and destruction during the past 800 years has been very extensive.

The creek called Pagham Harbour, on the south-east side of the Bill or peninsula, was due to an irruption before the year 1345, when 2,700 acres of land were destroyed. The site of the ancient cathedral and episcopal palace of Selsea, believed to have been situated to the south-east of the present church of Pagham, is no longer to be determined, but there is no reason to doubt but that it stood nearly a mile out in what is now sea. Camden, in his "Britannia," states that "in this isle remaineth only the dead carcase as it were, of that ancient little citie (where those bishops (of Selsea) had their seat), hidden quite with water at every tide, but at low water evident and plain to be seen."

The Bishop's Park, as the shore and sands are still called, extended for many acres on the south-east coast, and the remaining fragment has still the name of Park Coppice. The sea has gained more than a mile on this coast since the see and cathedral of Selsea was established, A.D. 680; Wilfred was the first Bishop of Selsea in that year, and Stigand was the first Bishop of Chichester, A.D. 1070. No less than twenty-two Bishops had occupied the episcopal chair of Selsea, and resided there, before the removal to Chichester. The parish that divides Selsea from Bognor is called Pagham, and the extensive estuary, which is a mile long and broad in places, Pagham Harbour. The remarkable church is dedicated to St. Thomas à Becket, and the ruins of the archiepiscopal palace are still visible south-east of the church. Archbishop Becket resided here with a large retinue, and his interference with a manor within his lordship, gave rise to his dissension with Henry II. which terminated in his assassination. That part of the coast marked "the Park," now covered by the sea, was part of the prelate's extensive estate, and is still visible at low water. The houses of the village are built of an arenaceous limestone almost entirely made up of microscopical shells, of the genera *Miliola* and *Alveolina*. This stone was formerly procured abundantly from an extensive range or ledge of rocks (calls the Clibs and Mixen) south of Selsea Bill, and extending some distance east and west. In 1830 the removal of this bed of stone was forbidden, forming as it did and does, a barrier to the encroachment of the sea.

This digression and somewhat archæological dissertation is necessary for my purpose, when drawing your attention to those recent geological changes that have taken place along that coast almost within modern times.

Thorney, Ham, and Medmeney marches, behind Bracklesham Bay, and between Bracklesham and Selsea, are of marine or estuarine origin, separating Selsea from the mainland, making it what its name expresses, an island, "Seles-eu," or "Island of the Sea-calf." We are thus led to believe that when Selsea became known to the English nation it was an island, and that in Bede's time the process of silting up the estuary must have commenced, and the completion of this process would seem to have been before the Conquest. The action of the tides on this coast carries the sand and shingle from west to east, therefore the gradual wasting which has taken place on the shore of Bracklesham Bay has served to supply a large portion of the material of which these marshes are formed.

The ground on which Selsea, Bognor, Littlehampton, Worthing, and other places on the Sussex coast westward of Brighton are built, is of very recent formation, being composed of gravels, sands, and loam belonging to the post-Pleiocene or Pleistocene series. These superficial post-Pleiocene beds overlie the well-known Eocene series in patches, and contain a large fauna. No less than 66 genera and 142 species, chiefly mollusca, occur here. The remains of the *mammoth* or *elephant* (*E. primigenius*, or *antiquus*) occur in the muddy deposits [*mud-deposit*]. With these are associated marine shells of existing species, but some not known now as such on the Sussex coast. East of Bognor, at low tides we have the remains of a sunken forest, and west of Selsea the trunks and roots of trees, &c., may be examined at low water. These trees in both areas are not fossilized, but evidently destroyed by the encroachment of the sea, probably since the time when "the Park" existed. In July, 1877, Mr. H. Willett, of Brighton, obtained from the beach below high-water mark, near East Wittering, a large number of bones of rhinoceros associated with several species of land and freshwater shells of existing species. The bones lay in the midst of decayed trees in a peaty deposit beneath the glacial beds of Selsea. An almost perfect skeleton of the *Elephas antiquus* is in the Museum at Chichester, which was obtained from the "mud beds" or "mud deposit" off Selsea Bill; multitudes of the shell *Pholas crispata*, occur in the same bed. Teeth of the mammoth have occurred in the "mud deposits" of Bognor, Littlehampton, and Worthing; and we have again the well-known "Elephant bed" at Brighton, doubtless of the same age.

At the British Association meeting in 1851, Mr. Godwin-Austen, F.R.S., then president of the Geological Section, called attention to the evidence of repeated oscillations of level of no very remote date which were to be observed in parts of the coast of Cornwall, Devon, the Channel Islands, and the Cotentin, an area comprising the western opening of the English Channel. As before stated, the same distinguished physicist, four years later, in his paper "On the newer Tertiary Deposits of the Sussex Coast," exhaustively described the phenomena of the later movements of the land, and interchanges between the sea and the coast. The oldest of the newer-Tertiary deposits of the Sussex levels in ascending order is to be seen only at extreme low-water in Bracklesham Bay; thence eastward round Selsea Bill, as far as the entrance into Pagham Harbour.

This portion of the Sussex series forms the "mud-deposit" of Mr. Dixon. Its character and composition distinguish it from the beds above. Is is composed of an extremely fine tenacious dark grey sandy mud, which resists the action of the sea; it rests upon the well-known Eocene Nummulitic strata.

The thickness of this Lutraria clay or "mud-deposit," can only be estimated at low-water spring tides; in places it is from 18 to 20 feet thick; it increases seawards and passes away beneath the sea-bed. On the coast near Medmeney (west side of the Bill) the surface of this clay is occupied by the remains of a colony of *Pholas crispata*, which has burrowed into it. This species attains here to great dimensions, and from its restricted range and littoral habit serves to determine the level of the tidal waters at the *commencement of the Selsea deposits*. The relative age of this old estuarine deposit of Selsea is determined by its mammalian remains. Those of *Elephas primigenius* are tolerably abundant, and the interest attached to them is enhanced by the fact that they do not occur here as single and detached teeth, or portions of tusks (as occurs on the higher gravels), but so many parts have been found together as to leave no doubt but that entire skeletons still lie embedded in this deposit. The head with the teeth and tusks and numerous bones have been found in close juxtaposition, and are now placed in the Chichester Museum. No less than sixty-six genera and 151 species of mollusca have been found here, or thirty-three genera and eighty-nine species of gasteropoda, and thirty-three genera and sixty-two species of pelycipoda, have been obtained from the Lutraria clay or "mud-bed." I may mention, among so many, the rarer shells that occur.

Cerithium reticulatum, da Costa. = C lima Brug.—A Spanish, Portuguese, and Mediterranean shell, comparatively recent within our area.

Fusus turricula (Pleurotoma).—A boreal Atlantic species, occurs in the Red crag. Scarce in the Faluns and Bridlington.

Pecten polymorphus, Bronn.—Lisbon, Mediterranean, very rare fossil in Italian and Sicilian beds.

Tapes decussata, ranges south but not north of British Islands. Common in the Mediterranean.

Lutraria rugosa.—Algeria and Morocco (living), also Canaries. South of Spain and Portugal.

Syndosma Boysii (Amphidesma).—Atlantic; rare; ranges to coast of Spain.

Pholas crispata Linn.—Rare on south coast of England, a Scandinavian species, and is found in the Crag.

From "the assemblage of mollusca, and the patch of *Pholas crispata* in conjunction with conditions of the deposit, we may infer that the relation of the land to sea-level was then much what it is now, or that these ledges of mud-beds in which this shell is found, then lay between tides." Many of the bivalve mollusca (Peylicipoda) lived in and on this mud, which is evident from the position in which the shells are now found, especially the *Myæ*, *Lutrariæ*, and *Pullastra* (Tapes)." "This area," according to the views of Mr. Godwin-Austen, "must have been an enclosed salt-water lagoon. The list of shells must be considered a special one, the result of local conditions subordinate to, but indicative of a much larger marine fauna which had its full development in some adjacent sea," and this fauna as a whole differed as much from that of the present Channel waters, as the fossil contents of the Selsea mud-deposits do from the mollusca now inhabiting the series of large creeks and lagoons extending from Fareham to Pagham." As regards the molluscan fauna of Selsea, some of which, now found on the Sussex coast, are essentially southern and western, do not range further north, or into the German Ocean area, and this southern relation of the fauna of the Lower Selsea deposit (*Lutraria mud deposit*) is still further strikingly illustrated by the presence of the before-mentioned two remarkable species, *Pecten polymorphus* and *Lutraria rugosa*, neither of which are now known to range further north than Lisbon. "We therefore have indications of a warmer condition of the waters of the English Channel, which allowed southern forms to range to a more northern latitude than now, and then a limitation of these forms to the area where now found, or in the Sussex deposits." The inference drawn by Mr. Godwin-Austen as to the manner in which the elephant's remains occur in this Lutraria clay is an obvious and an interesting one, as it enables us to arrive at a relative geological date, showing that the lower estuarine beds of Selsea and of the Sussex levels generally were contemporary with what is known as the period of the large mammalian fauna.

Overlying this Lutraria or mud deposit, there occurs a tough, calcareous, sandy clay; with chalk, and chalk flints—waterworn and of large size. This Yellow Drift clay is of marine origin, determined by the associated mollusca; Littorina and Mytilus being disseminated through the mass. This deposit occurs over the whole of the Selsea peninsula, and extends inland beneath the Sussex levels. Besides the large masses of flints and materials from the chalk, oolitic rocks, and chert-sandstone from the Upper Greensand, resembling that occurring at Lyme and Charmouth, there are other rocks which, from their "ages, composition, origin, size, and condition," render the mode of accumulation a problem of great geological interest. "The rocks in question consist of grey porphyritic granites, red syenites, syenite, hornblendic greenstones, micha-schists, green fissile slates, masses of quartz from veins, siliceous sandstones," such as occur in the Palæozoic series (Lower Silurian) of Normandy, micaceous sandstone with orthides, probably from the Devonian beds, and blocks of compact limestone, whether from the Devonian series of Devon or the Cotentin (France), is uncertain."

In size these older rocks range from coarse shingle up to masses of 20 tons weight, the granitic rocks being the most numerous and of the largest dimensions. A mass of porphyritic rock was exposed near Pagham by coast-line denudation, measuring 27 feet in circumference. Whence came they, and how brought, or what the transporting agent beyond that of floating ice, we know not. I must refer you to Mr. R. Godwin-Austen's original paper for matter of the highest interest relative to the original history of the yellow clay and the conglomerate bed, and later deposits in Sussex, as well as other phenomena bearing upon the present aspect of this singular area—a description of the complex nature of the structure of which would here be out of place. "What was the condition of the English channel as to its coast-line when certain marginal accumulations were being formed?" To answer this demands a profound acquaintance with the *old physical geography* of the district both of Northern France and Southern England.

The Brick-earth.—Above the yellow clay and mammalian gravels, the highest or uppermost deposit on the coast, there occurs a uniform bed of dark chocolate coloured unstratified clay, averaging about 3 feet in thickness. This clay forms part of that great layer of earthy matter which overlies all the gravel and other beds of the Sussex levels, and is extensively used for brickmaking. This brick-earth is a subaërial deposit, probably occurring as the wash of a terrestrial surface under a greater rainfall than we have now. This deposit is conspicuously shown along the shore, and forms the low cliffs of Bracklesham Bay. To this period Mr. Godwin-Austen refers the "*Combe rock*" of Selsea. He then refers to the condition of the English Channel area, at the period of the Crag-deposits of the German Ocean. The author is disposed to the belief that this Channel area was mostly in the condition of dry land at the time that the area of the German Ocean was occupied by the Crag sea. The peculiar molluscan fauna of the Sussex deposits point to a limitation of a *marine province* in that direction, whilst their habits indicate at the same time shallow water and marginal conditions. The temperature of the water of the English Channel during the period of the *Elephas primigenius*, and its associates, was such as now occurs 12 degrees or nearly 800 miles further south. In 1871 Mr. Alfred Bell examined with great care the fossil contents of the Lutraria clay or mud-deposit; he has added materially to the hitherto published lists of contents of this deposit. The result proves it to be unique as regards the fauna. "Of the 144 species of shells Mr. Bell states that 30 do not exist nearer than the West of England, the Channel Islands, north of Spain, 8 or 10 not passing this side or north of Gibraltar, all being littoral (or sub-littoral) species. As British Quaternary fossils 45 are peculiar to Selsea, and 20 others probably find here their earliest place in British geological history." Numerically the contents of this mud deposit are as follows: mammalia, 5 genera and 6 species; mollusca (bivalves), 33 genera and 62 species; univalves, 32 genera and 80 species; polyzoa, 2 species; crustacea, 8 genera, and 10 species; echinodermata, 2 genera and 2 species; foraminifefa, 9 genera and 10 species. Most of the fossils occur opposite Thorney coastguard station, where the Lutraria clay rises at intervals in low hummocks. The elephant remains appear to be those of *E. antiquus*. The tooth of *E. meridionalis* has also occurred here, an association resembling the Forest-bed of Cromer. In the Chichester Museum there exists the greater portion of a fine skeleton *E. antiquus* obtained from this mud deposit.

I have thus dwelt at some length upon these post-Pleiocene or Pleistocene beds at Selsea, owing to their local interest, and hope by so doing to induce any present who may be interested in the Quaternary geology of the British Islands, especially that of Sussex, to visit Bracklesham Bay and Selsea, near to which we are now assembled.

THE EOCENE FORMATIONS OF SELSEA AND BRACKLESHAM BAY.

It is impossible to pass unnoticed the Eocene tertiaries that occur in Bracklesham Bay, the stratigraphical position of which has long been settled, comprising the middle portion or fossiliferous division of the Bagshot Series. The Bracklesham beds take their name from the Bay in which they are so characteristically developed, yet difficult to clearly understand. The main divisions extend from Wittering, on the west, to the Barn Rocks, east of Selsea Bill, a distance of seven miles.

The Hampshire basin alone, in England, contains the nummulitic series, no fossiliferous representative being known in the London basin.

About a mile to the east of Selsea Bill is situated the "Park bed." This Park bed is analogous or equivalent to the "Calcaire grossier" of Grignon, in the Paris basin.[1] It contains thousands of Nummulina lævigata associated with Pernæ, Bullæ, Cypræa, Solens, besides the well-known coral Litharea Websteri. The Park bed is situated close to the shore, and is accessible at low water. It is here at low spring tides that the very recent post-Pleiocene beds may be seen overlying the Eocene deposits. At the Bill the Eocene beds are shown at low water in large detached portions called the "Clibs," the larger portion lying to the south-west, and the so-called "Mixen Rocks," marked by the "Mixen Pole," trend about a mile out into the sea. From these rocks, which extend a mile and a half east and west, and varying from 200 to 400 yards wide, is procured the Alveolina or foraminiferal limestone; the "Clibs" rock contains scarcely any other fossil remains. The *Houngate* Rocks, the same as the *Mixen*, are situated opposite Old Thorney Station House, and are visible at low water; they are nearly a mile in extent, and vary from 50 to 60 yards in width. Certain fossils have given names to the beds that range through the bay. The remarkable shells *Cypræa Coombii*, the great *Cerithium* (*C. giganteum*), and *C. cornucopiæ*, *Venericardia planicosta Turritella terebellata Conus diadema*, &c., amongst many others, aid us to determine the beds stratigraphically—locally the "Barn bed," "Palate bed," "Venericardia bed," the "Park," &c, serve to mark horizons of importance.

Opposite the New Thorney Station are the Scrobicularia or Lutraria clays or mud deposits from which the elephant remains were obtained.

The Rev Osmond Fisher, in his description of the "Bracklesham beds" of the Isle of Wight basin, restricts the name to a group of strata rich in organic remains, the greater part of which are displayed at low water upon the shore at Bracklesham Bay in Sussex. He also includes under that name higher beds than any seen at Bracklesham Bay that occur at Stubbington and the New Forest. He groups certain strata which appear to intervene between the base of the Barton series and the highest beds at Bracklesham Bay on account of their containing an assemblage

---

[1] Four hundred species of Mollusca have been found in the French deposits.

of fossils more akin to the fauna of the Bracklesham than the Barton.

"No marine fossiliferous beds are known *below the lowest* at Bracklesham Bay, until we reach the Bognor Rock of the London clay—at Bognor—except it be a thin stratum of clay at the very base of the Bracklesham series at the Whitecliff Bay. The following shells range through the Bracklesham group, and are confined to it, viz., *Venericardia planicosta*, *Sauguinolaria Hollowaysii*, *Solenobliquus*, *Ctherea suberycinoides*, *Voluta cithara*, *Turritella sulcifera*, and *Pecten corneus*; the last-named species occurs in the High Cliff beds." The Rev. O. Fisher, through the confined range of certain species, has divided the whole series into four principal groups. Vide *Quarterly Journal of the Geological Society*, vol. xviii. pp. 66—75.

Group A The upper, abounding in gasteropoda, and has *one of its fossil beds* in the eastern part of its range full of *Nummulina variolaria*.

Group B is more sandy in its general condition, and distinguished by the presence of the large gasteropoda. *Cerithium giganteum*, *Nummularia variolaria*, occurs in this member at Whitecliff Bay.

Group C Sandy like the last, but its chief fossil-bearing bed is profusely crowded with *Nummulina lævigata*.

Group D embraces the lowest fossiliferous sands of Bracklesham Bay the distinctive shells are *Cardita acuticosta*, and *Cypræa tuberculosa*.

Bracklesham beds at Whitecliff Bay.—These beds rest on the Lower Bagshot sands, and agree with bed No. 6 of Professor Prestwich's section, their base being distinguished by a bed of rolled flint pebbles about one foot in thickness.

Reading in descending order Mr. Fisher's group A. including the beds xix., xviii., xvii., xvi., xv., xiv., and xiii., correspond with the beds numbered 17, 16, 15, and 14 in Professor Prestwich's; together they measure 254 feet. The position of the beds here renders them easily accessible at Bracklesham Bay, but they are nearly horizontal, and consequently must be paced to be understood. Beds No. xvii. and xiv, of Group A are the most fossiliferous, and both contain *Nummulina variolaria*.

Mr. Fisher's Group B includes beds xii., xi., x,. and ix., or Professor Prestwich's No. 13. No. ix. of Fisher and 13 of Prestwich is the chief fossilliferous bed. *Nummulina variolaria*, *Voluta nodosa*, and *Sanguinolaria Hollowaysii*, are the chief fossils in this bed, the thickness of the group is only 27 feet.

Group C with beds viii., vii., and vi., correspond to Professor Prestwich's Nos. 2 and 11. No. vii. contains the distinctive and characteristic nummulite, *N. lævigata*, also equally abundant at Bracklesham Bay with *Sanguinolaria Hollowaysii*, bed No. vi. of Fisher, and No 1 of Prestwich is very fossiliferous. These three beds measure 123 feet.

Group D is composed of beds No. v., iv., iii., ii., and i., or Nos. 10, 9, 8, 7, and 6 of Prestwich. The only fossiliferous bed in this group is No. iv. of Fisher, and 9 of Prestwich, in which the great *Venericardia planicosta* abounds, as at Bracklesham Bay, the fine shell *Cypræa tuberculosa* not occurring at Whitecliff Bay. The beds comprising this group are 251 feet thick; in all, the Bracklesham beds at Whitecliff Bay measure 653 feet. I have deemed it important to partly particularize this remarkable section at Whitecliff Bay by way of comparison with the fine section shown at low water in Bracklesham Bay, where the beds occupy the shallow shore for three and a half to four miles, and are nearly horizontal, or dip S. by E., with a strike of W. by S. and E. by. N. So nearly level are the beds, that there is no oqportunity given to measure the dip or thickness with accuracy. Mr. Fisher, in his excellent section, has given the order of succession of the beds, and the distances between the outcrops. The beds exposed towards, or near Selsea Bill, belong to the upper members, and their strike is nearly tangential to the shore, consequently we continue our walk upon the same outcrop for a long distance in step-like planes. I give the Rev. O. Fisher's section and sequence round Selsea Bill, as he observed them, as a guide to those who may visit the area. Vide *Quarterly Journal of the Geological Society*, *loc. cit.*

Commencing at a spit of gravel seen at low water off "the Bill," brought together by the meeting of the tides from the "Park" and Bracklesham Bay, and going westward or towards Wittering, we have the following ascending section:[1]—

	Paces
"Beds then covered with sea sand . . .	600
Outcrop of septaria, on sandy clay weathered green beds covered with sea sand . .	127
Hard dark grey, sandy bed, nummulitic in upper part (nummulites abundant at 216 paces, concretions at 226 paces) . . .	420
Nummulina variolaria, and other foraminifera in clay	324

"Taking up this last-named bed again as being *the highest distinguishable* at this place, we then have the general descending series along nearly three miles of the shore" westwards.

Descending Section of Bracklesham Beds at Bracklesham Bay

A.	22.	Clay.—*Nummulina variolaria*, *Alveolina sabulosa Quinqueloculina*, *Hawerina*, *Biloculina ringens*, *Rotalia obscura*, *Turbinolia sulcata*, &c.	324
	21.	Hard calc. sand; "HARD BED" foraminifera, *Tellinæ*	140
	20.	Greyish clay with *Corbulæ* and *Nummulinæ*	120
	19.	(*d*). Dark clay (Cypræa bed, Dixon) . .	460
	18.	Sandy clay containing same shells as 19 (*d*) .	66
	17.	,, ,, green foss. in upper part . .	194
		Pleistocene mud[1]	112
		Green sandy clay	300
B.	16.	(*e*). Sands full of casts, bivalves . . .	218
		Pleistocene mud[1]	80
	15.	Hard sand, weathered green . . .	70
	14.	Shelly sand, greenish-brown, full of fossils, *Cerithea* and *Cytherea striatula* (Little bed)	29
	13.	Dark sandy clay with *Turritella imbricata* .	240
		Pleistocene clay, laminated *Ostrea edulis*, &c.[1]	124
	12.	(*f*). Dark Clayey sand with numerous *Cerithium giganteum*, *Pectunculus pulvinatus*, &c., &c.	163
	11.	*Septaria*, resting on shelly sand with black flint pebbles	150
	10.	Laminated liver-coloured clays, sandy towards the bottom	246
	9.	*Ostrea tenera* bed, 18 inches thick . .	52
	8.	Dark green sand, full of broken shells, *Pectunculus pulvinatus*, *Lucina*, *Bulla Edwardsii*	
		Towards upper part (79 paces less) . .	175.
		Shelly in the middle (48) abounding in *Turritella terebeilata* at the base . . .	
	7.	Soft laminated dark-coloured clay . .	177
		Pleistocene mud, out of which places protrudes a clay weathered green[1] . .	288
C.	6.	(*g*). *Nummulina lævigata* bed, with numerous fossils (Little Park bed)	40
	5.	Sandy clay, weathered green . . .	107
		Beds covered partly with sea-sand and partly with Pleistocene mud	105
	4.	(*h*). Dark mottled clay, shells and scattered nummulites, *fish* and *serpent* remains ("Palate Bed")	134
		Covered with sea sand	96
	3.	Dark sandy clay	53
		,, ,, ,, with broken shells . .	111
		Covered	30
D.	2.	Turritella bed, *T. imbricataria* and *T. sulcifera*	92
	1.	Septaria containing shells and occasionally *Rostellaria ampla* (68 paces), resting on a mass of *Venericardia planicosta* and *C. acutirostra*; the lower part of the bed is Greensand crowded with shells, among which immediately beaeath the *Carditæ*, the *Cypræa tuberculosa* occurs. The bed then become less fossiliferous, and passes into a dark grey laminated clay, broken up and re-arranged, mixed with dark sand and black pebbles ("Barn bed," Dixon) .	330
			5,016

---

[1] Every yard of this bay and its extended beds were measured and paced, and the map constructed by Mr. Bristow and myself, and the fossils observed in the numerous thin beds comprsing the section.

[1] These clay beds are nearly modern in age, and cover up unconformably the underlying Bracklesham beds.

Below this no fossils found.

The Park on East side of Selsea and the Mixen Rocks.

On the east side of the Selsea peninsula, the highest bed seen is the *Nümmulina lævigata* bed, rich in fossil. All the succeeding beds down to the *Venericardia planicosta* bed are usually exposed at "the *Park*."

Mixen Rocks.—A ledge, one mile south of Selsea Bill, composed of a *Miliola* and an *Alveolina*, continuation of No. 22(*b*) only more calcareous.

BOURNEMOUTH AREA.

The geology of this remarkable area has received attention from several explorers. Sir Charles Lyell in 1826, Professor Prestwich in 1848, the Rev. O. Fisher in 1861, and in the year 1878 Mr. John Starkie Gardner prepared and read an able paper on the "Description and Correlation of the Bournemouth Beds." Part I., the Upper Marine Series (*Quarterly Journal of the Geological Society*, vol. xxxv. pp. 202-228. 1879.), treating of the coast section between Bournemouth and Highcliff; and a second paper, Part II., on the lower or Freshwater series (*Quarterly Journal of the Geological Society*, vol. xxxviii, pp. 1-15.). He states his reason for differing from the previous writers upon the succession of the beds and their correlation with other localities. Mr. Gardner's researches endeavour to show that the celebrated Bournemouth leaf-beds immediately underlie the true Bracklesham series, and are, unlike those of Alum Bay, of *Middle* and not of *Lower Bagshot* period, hitherto the received view as to their age. The author has also ascertained that a great portion of the cliffs between Hengistbury Head and Bournemouth are of marine origin, and highly fossiliferous. These marine beds comprise two distinct characters, which the author traces across to Alum Bay in the Isle of Wight. Mr. Gardner also differs from the Geological Survey in believing "that the so-called Upper Bagshot beds of the London basin do not belong to that series, but are the equivalents of his Boscombe sands, these sands, and the marine Bournemouth beds being, according to his researches, the western equivalents, or extreme shore-condition of the Bracklesham sea."

At Highcliff, nearly under Rothsay Castle, both the Barton and the Bracklesham series are exposed, the Barton being not more than 10 feet in thickness, and the subjacent Bracklesham 40 feet. The section is revealed to the sea-level, and therefore highly instructive. The Highcliff sands conformably underlie the Barton and Hordwell series at an angle of 2° to the E. The remarkable promontory of Hengistbury Head is mainly composed of strata contemporaneous with the Bracklesham series; and which Mr. Gardner would for convenience call the Bournemouth beds. Hengistbury promontory in shape resembles a parallelogram obliquely truncated at its northern extremity. The cliffs facing the sea on the south are about 50 feet high, increasing to 100 feet on the north, both presenting bold escarpments to the sea. "The succession of the strata at Hengistbury Head, reading upwards, comprises, 1, the Boscombe sands; 2, a lower series of sand with green grains, and an upper bed with ironstone; and 3, the white Highcliff sand. The white sands at Highcliff are 30 feet thick, being 12 feet thinner than the equivalent beds at Alum Bay, where they measure about 42 feet." The lowest series in the cliffs at the headland Mr. Gardner terms the "Boscombe sands," which without any doubt represents the chief mass of brilliantly coloured sands, about 750 feet thick, at Alum Bay, known to all explorers of the island. These coloured sands are numbered 25 and 26 in Professor Prestwich's section of the vertical beds in Alum Bay (Vide *Quarterly Journal of the Geological Society*, vol. ii.). Mr. Gardner also notices another hill similar in contour to that of Hengistbury, about three miles to the north of the Head. This, St. Catherine's Hill, possesses, like the headland, similar physical features, being flat-topped and having abrupt escarpments on all sides, and 160 feet high. Both the Highcliff sand and the Hengistbury beds occur in this hill, showing their connection and continuity inland with the coast section. "The correlation of the Hengistbury Head series on the mainland with those of Alum Bay across the Solent admits of little doubt, and they would appear to be represented at Alum Bay by the *Highcliff sands*, 25 feet in thickness, and equivalent to bed No. 28 in Prof. Prestwich's section. The Hengistbury Head beds appear to be the equivalents of bed No. 27 in the Alum Bay section. The Boscombe sands represent beds No. 26 and 25 of Prestwich in Alum Bay, where they are 150 feet thick. It can be conclusively seen from examination of the cliffs in the Bay from Hengistbury to Bournemouth that there is a general sequence, and that the strata have an amount of dip or inclination, sufficient in so extended a distance to expose two complete series of beds, the upper series, being the continuation of the Boscombe estuarine sands, 100 feet thick, and the lower series of sands and clays, of marine origin, which Mr. Gardner has provisionally termed the Bournemouth marine beds." With Mr. Gardner's paper in hand the most minute details of the coast may be followed (*Loc. cit.* 217-226.), from the Head towards Bournemouth. These, both for physical and palæontological details, I must therefore refer to you, as giving step by step an analysis of the structure of the cliffs, and the flora contained in the clays and sandy series of which they are composed. This flora of the Bournemouth bed marine may be referred to the Middle Bagshot series, and the Bracklesham division, possibly representing the same stage in the London basin, and it would appear from careful consideration of the Middle and Upper Bagshots that no Eocene beds younger than the Bracklesham are met with in the London area, a geological fact of much significance as compared with the complete succession of the 'Eocene series as developed in the Hampshire basin, and that of their equivalents in the basin of Paris. Mr. Gardner believes that "the fossil plant remains of the Bournemouth beds, especially those in the marine series, are of the same age as those in the Bovey Tracey deposits, which have been wrongly assigned to the Miocene period, believing, in fact, that they are simply an outlier of the Bournemouth series, now 80 miles to the west," but formerly and originally connected as a western extension of the Bournemouth deposits.

Comparison of the flora of the two areas shows a close affinity, if not identity of species, *Osmunda lignata*, *Lastræa Bunburyi*, *Palmacites dæmonorops*, the fruit, conifers, and dicotyledons being not only specifically identical, but occur in the same combinations and manner of preservation," *loc. cit.* pp. 227, 228. *Polypodium*, *Chrysodium*, *Pteris*, and *Osmunda*, amongst the ferns; *Eucalyptus*, branches of Sequoia, pods and leaves of the Leguminosæ, *Nipadites*, *Dryandra Cacti*, *Anona*, *Hightea*, &c., occur in the beds constituting the western termination of the Bournemouth marine series. The fauna testifies to its marine derivation: the genus *Ostrea*, *Arca*, *Modiola*, *Tellina*, *Calyptræa*, *Phorus*, *Natica*, and *Cerithium*. The crustacea, through Callianassa, and a shore crab, with Bryozoa (Flustra), needs no other comment. The changing physical characters of the beds of the Bournemouth series, both horizontally and vertically, the marshy character of the flora, "as represented by the ferns, aroids, Eucalyptus, &c., the patches of clay, in which the water-plants, ferns, &c., may have rooted, the local patches of ironstone, the intercalated marine beds and their fauna mingled with unios, clearly shows that this was the debateable ground between sea and river, beyond which to the west it would appear the sea never then penetrated." In February of the present year, Mr. Gardner communicated to the Geological Society his second paper on these Bournemouth beds, being a continuation of his former notice, but in this his researches are confined to the history of the "Lower or Freshwater Series" (*Quarterly Journal of the Geological Society*, vol. xxxviii.) of the Bournemouth area. The author describes the geological structure of the Eocene cliffs as far as Poole harbour. All the strata between Bournemouth and Poole harbour are of freshwater origin, and are highly interesting on account of the fossil flora recently obtained from them by Mr. Gardner—undoubtedly the most extensive, richest, and most varied hitherto discovered or extracted from the Tertiary formations. No less than nineteen species of ferns have been described from these beds. Only ten species have been met with in all the other British Eocene deposits, including the famous Bovey Tracey beds, and three of these ten are also found at Bournemouth. Sir C. Lyell, in 1827, the Rev. P. B. Brodie, in 1842, Mantell, in 1844, Prof. Prestwich, in 1847, Trimmer, in 1855, De la Harpe, in 1856, and Heer, in 1859, have all written upon the flora and its associated conditions, origin, &c. In 1862, the Geological Survey, through the Memoir by Forbes and Bristow upon the Isle of Wight, held the view that the fossil flora of Bournemouth, Corfe, and Alum Bay, were identical, although few species were common to these localities. "The cliffs comprising the Bournemouth freshwater series extend from Poole harbour on the west, to beyond Bournemouth, and present escarpments averaging about 100 feet in height, composed of yellow, white, orange and black sands and clays, crowned with fir-trees or pine woods.

Mr. Gardner places these Bournemouth beds in the Middle Bagshots, drawing the line between these and the Lower Bagshots at the pipe-clay beds of Corfe, Studland, and Alum Bay in the Isle of Wight. This line of division is drawn on account of the great dissimilarity of the flora contained in each. The Bournemouth flora, which is distinct from the older, or Alum Bay series, passes up into the so-called Oligocene without any perceptible change or break; but few, or none of the same species pass down or occur with the Alum Bay beds.

These Middle Bagshots are represented in Alum Bay by the unfossiliferous beds marked 19 to 24 in Professor Prestwich's section, (*Quarterly Journal of the Geological Society*, vol. x. p. 56,) and are 240 feet thick. Palæontologically, these beds may be correlated with the continental Eocene, probably those of Aix-la-Chapelle. The cliffs fronting the sea may be divided into three groups. The first extends from Poole Harbour to Bateman's Chine, the second group extends from the Sugar-loaf Chine to Watering Chine, the third section or group extends from Watering Chine to the Bourne Valley.[1] The chief interest attached to the Bournemouth beds is the flora distributed chiefly through the *Lower or Freshwater Series.* None of the prevailing Alum Bay types are found at Bournemouth, nor are any of the well known Bouremouth types found at Alum Bay, and according to Mr. Gardner, their affinities are completely with the floras ascribed in France to the Oligocene, and the forms of flora as at present known, chiefly Australian and tropical American.

The author has endeavoured to show that "a great river existed throughout the whole of Eocene times, bringing deposits from the westward, and that the Bournemouth cliffs present a section across its bed, these deposits being formed during a continued period of subsidence." The sudden change observed in the beds from fine to coarse sediment, and the thickness of the deposit, cannot be explained by the floods and freshets incidental to changing seasons, but are such as would occur whenever subsidence exceeded, in however trifling a degree, the silting—up power of the river," *loc. cit.* p. 13.

It is a question of importance whether the continental floras similar to our own at Bournemouth have been correctly determined. "For while all the strata that have yielded dicotyledonous leaves or fruits below our Headen series are admitted to be Eocene, scarcely any of the beds on the Continent resembling them are ascribed to that age," but to the Miocene. "For as all Eocene floras approximate more or less to Miocene, it has been a kind of rule in the absence of stratigraphical evidence, to assume that all isolated patches with dicotyledons, belonged to the latter period, and had the stratigraphical evidence at Bournemouth been inconclusive, the whole of that Eocene formation must also upon plant evidence (for we have no other) have been classed as Miocene.

The *Lower Freshwater series* are seen in the neighbourhood of Corfe and some parts of the cliffs at Studland. It is characterised by abundance of pipe-clays, and is about 200 feet thick.

The *Middle Freshwater series* also occurs at Cofe and Studland, and form the whole thickness of the cliffs between Poole Harbour and Bournemouth, thus constituting a fine section, 4 miles long and 100 feet in height,

The next series is marine, and about 400 to 500 feet thick. This marine group occupies the cliffs between Boscombe and High Cliff.

The Bournemouth flora appears to consist principally of trees or hardwood shrubs, few remains of herbaceous plants being preserved. The ferns are rare in the lower part of the series, but become more abundant, almost to the exclusion of other vegetation, towards the close of the middle period.

The prevailing group appears to be that of Acrostichum, of which there were many species. *Angiopteris, Neprodium, Gleichenia,* and *Lygodium*, and other undescribed forms occur.

Among the *Coniferæ, Cupressus, Taxodium,* and *Dacridium*, with indications of pinus. The Cycadæ seem to have disappeared.

The monocotyledons are well represented by reeds and rushes. *Nipadites*, represents the screw pines. The palms are very abundant, especially in the lowermost beds of Corfe and Studland and the upper middle beds of Bournemouth; many *Flabellaria, Sabal,* and *Phœnicites,* occur; the Smilaceæ occur in all the fossiliferous beds, and are represented by five or six species.

The Apetalæ, illustrated by *Populus, Ulmus, Laurus, Quercus, Artocarpidium,* and *Daphnogena*, with *Carpinus, Fagus, Castanea, Salix,* and *Ficus*, and numerous Proteaceæ.

Elæodendron, Rhamnus, Prunus, Juglans, Cluytia, Ceratopetalum, with *Dodonœa, Celastrus, Eucalyptus,* and many *Leguminosæ*, illustrate and characterise the Polypetalæ.

Cactus and *Stenocorpus* are added for the first time to the Eocene dicotyledons.

Mr. Gardner believes that we have probably represented almost every genus descended from Continental floras.

The Eocene flora presents us with types peculiar to the Southern Hemisphere, and related to those of Australia and the adjacent islands. We have examples of this southern flora through the *Proteaceæ, Leguminosæ, Coniferæ,* and the *Myrtaceæ*, through *Eucolyptus*.[1]

ISLE OF WIGHT.

The present rhomboidal form or configuration of the Isle of Wight is due partly to the unequal action of the sea on its coast line, and partly to those disturbances or movements which have thrown some of its strata into the positions exhibited at Scratchell's Bay, Alum Bay, and Whitecliff Bay.

The rapid waste of the cliffs going on at Sandown and Freshwater Bays is due to the action of the sea, the Lower Greensand and Wealden strata there exposed being more easily destroyed than the chalk.

The leading physical feature in the structure of the Isle of Wight consists in the ridge of high and bare chalk downs near the centre of the island extending from the Needles on the west to Culver Cliff on the east. Another chalk range parallel to the former, but on the south of the island, extends from St. Catherine's Down on the west to Boniface Down on the east. In the space occupied between these two chalk ranges or upper cretaceous rocks, there occurs the complete succession of the lower cretaceous and lacustrine Wealden groups, comprising the Hastings sand and Weald clay exposed at Compton Bay and Rock Point on the west, and Sandown Bay on the eastern side. The central ridge is depressed and cut through by transverse valleys; such occur at Freshwater Gate, Shalcombe, Calbourn, and by the Carisbrook, Medina, and Brading valleys. "All these breaks may possibly be on lines of faults running or cutting through at right angles to the strike of the chalk."

The part of the Isle of Wight which lies to the north of the central chalk range is entirely composed of the older Tertiary or Eocene strata. The only fault of magnitude known in the island is that occurring along the line of the Medina valley. Those on the eastern side of the river are the Headon, Osborne, and St. Helen's series. The rocks at West Cowes, or west of the Medina, belong to the Bembridge marls or fluvio-marine series. "From the known thickness of the several groups the amount of displacement which takes place on the line of fault between East and West Cowes, or *along the line of the Medina*, cannot be less than 200 feet."

The longitudinal undulations affecting or disturbing the Tertiary strata north of the chalk ridges are less obvious than those above described. The chief flexures which are in immediate sequence with the chalk are exhibited both at Whitecliff and Alum Bays, where the Lower and Middle Tertiaries are inclined at very high angles.

The first set, or the east and west undulations, are connected with the movement that elevated the chalk vertically. The north and south undulations also affect the chalk, since each north and south valley formed by the synclinal curve or hollow of the roll, corresponds to the division between the two chalk downs, and each down to an anticlinal. All the Lower Tertiary strata, including the fluvio-marine beds, are affected by these movements.

The gravel beds, which rest upon the older Tertiary strata, whether the *oldest or higher* level gravels, or the newer, such as those which occupy the combes and transverse valleys, are *unaffected* by these movements, showing that their origin is subsequent to the disturbing forces which affected the Secondary and Tertiary rocks below them or on which they rest.

---

[1] For particulars of these three groups, see *Quarterly Journal of the Geological Society*. xxxviii. pp. 5-8.

[1] Mr. Gardner has been greatly aided in his floral researches by Constantin Baron Ettingshausen, Ph.D., who has brought to bear his great knowledge of fossil plants and their distribution through the higher Tertiaries. The joint monograph by Mr. Gardner and Ettingshausen on the "British Eocene Flora," in the Palæontographical Society's volumes for 1879 are of the highest value to Palæobotanical students.

Lower Tertiary Strata of the Isle of Wight.

The Lower and Middle Eocene strata of the Isle of Wight, especially up to the base of the fluvio-marine series, may be better studied in the cliffs in Alum Bay and Whitecliff Bay than in any other part of the island.

In these remarkable sections the whole of the strata from the chalk to the fluvio-marine formation are displayed in unbroken succession.

Plastic Clay.

"The lowest member of this group of strata in the Isle of Wight is the *Plastic Clay*, or Woolwich and Reading series of Mr. Prestwich." These beds are best examined in Whitecliff Bay and Alum Bay, especially the former, where the mottled beds are well exposed. No fossils have occurred in the plastic clay of the island. Seven beds have been recognised, the whole measuring 85 feet; they constitute a narrow belt striking across the island, resting on the chalk.

The *London clay* succeeds the plastic clay, and also forms a narrow belt extending across the island from the west coast at Alum Bay to the east at Whitecliff or Culver Cliff; its thickness is about 200 feet. A band of flint pebbles only 2 inches thick divides the plastic clay from the London clay, representing the basement bed of Mr. Prestwich. Nowhere in Britain can the London clay be so advantageously studied as at Whitecliff Bay, or where the characteristic fossils are better exposed. Twenty-five to thirty characteristic species may be collected here. Amongst others may be named *Pinna affinis*, *Pectunculus brevirostris*, *Pholodamya margaritacea*, *Panopea intermedia*, and *Modiola elegans*. The annelida *Ditrupa plana* belongs essentially to the London clay.

Middle Eocene.

Lower Bagshot Beds.

Joshua Trimmer, in 1850, first applied the term Bagshot to the whole series of strata in Alum Bay and Whitecliff Bay, dividing it into upper, middle, and lower, thus correlating it with the corresponding series in the London area which had been previously established by Mr. Prestwich.

The Lower Bagshot beds are greatly developed in the Isle of Wight, attaining a thickness in Alum Bay of 660 feet, the most important Geneva being Elæodendron, Taxites, Quercus, Juglans, Daphnogene, Laurus, Cæsalpina, Cassia, Ficus, Dryandra, Rhamnas and Sabal, &c. They comprise a series of variously-coloured unfossiliferous sands and clays, with accompanying iron sand tone and clay. These last beds are in one place crowded with the leaves of sub-tropical land plants illustrating no less than 19 families, 26 genera, and about 50 species. The *Araliaceæ*, *Casuarinaceæ*, *Celastraceæ*, *Coniferæ*, *Cornaceæ*, *Cunoniaceæ*, *Cupuliferæ*, *Cycadeæ*, *Ebenaceæ*, *Euphorbiaceæ*, *Juglandeæ*, *Laurineæ*, *Leguminosæ*, *Moreæ*, *Palmæ*, *Proteaceæ*, *Rhamneæ*, *Sapindaceæ*, and *Tiliaceæ*. The same strata at Bournemouth and Corfe Castle in Dorsetshire exhibit an identical but also richer flora. Out of thĕ great series found at Bournemouth through the researches of Mr. J. Gardner, fifteen or sixteen species occur in the pipe-clays of Alum Bay. As a whole they indicate a rather high temperature. The flora of the Lower Miocene beds, well known in Central Europe, has some affinities with that of our Hampshire basin.

The tropical or sub-tropical character of the London clay plants was long ago worked out by Dr. Bowerbank, but it was reserved for Dr. De la Harpe to carry his comparison into the Middle Eocene beds, and to show that there had been only a moderate decrease of temperature, so far as plants could show, in the time occupied by the deposition of the Bagshot or Bracklesham sands. The marine fauna of the same period fully bears out this conclusion, there being no essential difference between the fossils of the London clay and those of the Bagshot, or even the Barton beds, which would indi ate a marked change of climate.

The flora of the Alum Bay beds is especially distinguished by the number and variety of its Leguminosæ. The plant contents of the Lower Bagshot beds of Alum Bay approximate to that of the London clay by the predominance of plants of this family, forty-seven species of which were obtained by Mr. Bowerbank.

The junction between the London clay and the Lower Bagshot is clearly seen in Whitecliff Bay. The brown ferruginous clay representing the former, and the latter by pale grey or white sands about 40 feet thick. In the 640 feet of these Lower Bagshot beds at Alum Bay no other fossils are known than plants, and *about* 60 *species* occur.

Middle Bagshot Series.

Bracklesham Beds.

The strata comprised between the sands at the base of Headon Hill, and the pipe-clay bearing sands and clays (Lower Bagshots), overlying the London clay, are subdivided into Bar on clay and Bracklesham beds. The Bracklesham beds in Alum Bay are represented by clays and marls in the lower part, and by white, yellow, and crimson sands above. The lower beds are remarkable for the quantity of lignites, coaly or vegetable matter contained in them, constituting beds from 15 inches to 2 feet in thickness. The black and coal-like appearance of four of these beds are conspicuous and marked objects in the cliff, and determine the position of the Bracklesham series.

The uppermost beds of the series, or the yellow, white, and crimson sands, are totally devoid of organic remains, or are unfossiliferous. At Whitecliff Bay the lower part of the Bracklesham beds are green, clayey sands, containing *Venericardia planicosta*, *Turritella imbricataria*, *Nummulites lævigatus*. Six zones of fossils are there recognised. A hard bed of conglomerate composed of rounded flint pebbles in a ferruginous cement is also a marked feature in the cliffs at Alum Bay, defining the division between the Bracklesham and overlying Barton clay.

Barton Clay.

The Barton series, composed of sandy clays and sand with layers of septaria, is sufficiently shown in Alum Bay, where it attains a thickness of 300 feet, and is rich in fossil remains, the whole of which are marine, 48 genera; and 90 species of mollusca alone have occured at Alum Bay.

At Barton Cliff, on the mainland, or opposite coast of Hampshire, a rich and abundant marine molluscan fauna occurs. The lower beds at Alum Bay contain *Voluta luctatrix*, *Rimella*, (*Rostellaria*) *rimosa*, *Conus* or *Conorbis dormitor*, and *Fusus longævus*, with *Crassatella sulcata*, &c.

Upper Bagshot Sands.

These are the unfossiliferous sands below the Lower Headon beds, used extensively for glass-making, which may be 150 feet thick at Alum Bay. In Whitecliff Bay the junction between the Upper Bagshot sands and the Barton clay is sharp and well defined; a few casts of fossils occur here, but are in so friable a state that they cannot be removed.

Examination of the cliffs at Alum Bay will at once show that the strata from the chalk to the Upper Bagshots are highly inclined, caused by the force that produced the anticlinal axis which traverses the island east and west, and this axis brings to the surface the Wealden beds in Brixton and Sandown Bay, thus revealing the extent and continuity of the Wealden series, and determining its presence westward to the Isle of Purbeck along the same east and west line of elevation. Eastward of the Isle of Wight this axis is lost under the waters of the English Channel, and we have no visible proof of its influence towards Beachy Head; it may have aided in preparing a weakened line for the course of the Channel towards the Straits of Dover. These beds at Horwell Cliff have been the subject of a notice by Mr. Tawney in the "Proceedings of the Cambridge Philosophical Society," and will be referred to in the latter part of my address.

Fluvio-marine Series.

Of the fluvio-marine strata of the Isle of Wight, the *Bembridge* series is by far the most constant in *lithological characters*. The lower part, calcareous (marine and freshwater.) The upper part (largest) consist of alternations of marls and laminated clays.

By far the larger portion of the Tertiary surface of the Isle of Wight is occupied by the Bembridge series, which *overlie the Headon beds, or Headon Hill group*. Stratigraphically, or in a scientific point of view, they possess high interest, being *representatives of extensive continental formations*, through which we are enabled to correlate or throw considerable light on the classification of foreign Tertiary strata.

Through these Bembridge strata we are also made acquainted with and acquire much information respecting the terrestrial fauna of our own area during the later portion of the Eocene epoch.

Palæontologically the Upper Bembridge marls are characterised by the abundance of *Melania turritissima* These marls are finely shown in Whitecliff Bay, on the shore at Hempstead, and at Thorness, containing *Cyrena pulchra*.

The upper beds of the second group are exposed in the clearest manner through fine sections at the same places, and also at, or near Brading harbour, below St. Helen's. Remains of *Trionyx*, or the fresh-water tortoise, large cerithia (*C. variabile*), and *Cyrena pulchra* characterise these beds

The *third group*, or the Bembridge oyster beds, forms 'a narrow but constant band between the marls and the limestones. Marine conditions set in here, characterised by the abundance of *Ostrea vectensis*, *Nucula similis*, *Cytherea incrassata*, *Mytilus*, and *Cerithium*. These beds were long mistaken for the "upper marine" or Middle Headon strata. At Whitecliff Bay and Brading harbour this group may be advantageously studied.

The fourth subdivision, or Bembridge limestone, includes those beds exhibited at Binsted, Cowes, Calbourn, and Sconce (but not the limestones of the Headon series). It is important to remember this when correlating the British Upper Eocene deposits with those of the Continent.

This remarkable limestone in *Whitecliff Bay*, forms a conspicuous feature in the cliffs; it is also the marked feature at Bembridge ledge. When closely inspected it is found to be composed of a number of distinct beds or strata. In ascending order we readily recognise seven divisions, each characterised by freshwater mollusca and some few land plants.

Bed No. 1. Concretionary limestone containing the fresh-water plant *Chara tuberculata*, with *Lymnæa longiscata*.
,, 2. Greenish marly clay, *Lym. longiscata* and *Planorbis*.
,, 3. Compact creamy yellow limestone, *Lym. longiscata* and *Planorbis oligyratus*.
,, 4. Pale marly limestone, compact in places, full of *Paludina globuloides*, *Lym. longiscata*, *Hydrobia*, and *Cyclostoma mumia*.
,, 5. Greenish white limestone, concretionary and fossiliferous, containing *Lym. longiscata. Planorbis discus. P. rotundatus*, *P. Sowerbyii*, *P. obtusus*, *Helix occlusa*, *Helix labryrinthica*.
,, 6. Crumbly white marl, with globular concretions, *Chara tuberculata*, *Planorbis obtusus*.
,, 7. A similar bed to 6, with *Planorbis discus*. The whole about 25 feet thick.

The strata along the coast and section are in many places beautifully shown, and present peculiarities not elsewhere seen in the island.

The difference between the upper and lower portions of them is considerable, and may be separated—

1. The Upper, Forbes termed the St. Helen's Sands.
2. The Lower, the Nettlesome Grits.

THE ST. HELEN'S BEDS, OR OSBORNE AND ST. HELEN'S.

These lie between the Upper *Headon series* proper, containing *Potamomya* and the Bembridge limestones. These beds are of freshwater and brackish-water origin.

Paludinæ (*P. lenta*), *Melaniæ* (*M. costata*, *M. excavata*), *Melanopsis brevis* and *M. carinata*. *Chara Lyellii* is the Gyrogonite of this limestone band, which on the east side divides the Upper or Nettlestone beds from the Lower or St. Helen's sands.

Between the Bembridge limestone and the brackish-water beds with Potamomyæ, that terminate the Headon beds, a great series of strata intervenes, which on account of their mineralogical and palæontological peculiarities, deserve and hold an intermediate position between the middle and upper Eocene strata.

OSBORNE SERIES IN WHITECLIFF BAY.

Thickness 100 feet.—Dark red clays and bright red and variegated clays occur. (*Helix occlusa*, *Planorbis discus*, and *Lymnæa longiscata*.)

OSBORNE SERIES BETWEEN ST. HELEN'S AND RYDE.

Between Brading Harbour and Ryde sections occur, and on shore are seen the rocky ledges below Seafield, and from St. Helen's to Nettlestone. At Watchhouse Point, below St. Helen's, the Bembridge limestone forms an extensive arch.

HEADON SERIES. 170 FEET THICK.

Best seen at Headon Hill, Colwell Bay, and at Whitecliff Bay, and their lowest divisions at Hordwell. Everywhere *Planorbis euomphalus* characterises the fresh-water bands.

Potamomya plana, and *Cerithium pseudocinctum* abound in the brackish-water beds. *Cytherea* (*Venus*) *incrassata*, accompanied by many shells, occur in the marine division.

The group may be divided into three sections, Upper, Middle, and Lower Headon.

Upper Headons.—These constitute the greater portion of the *Upper Freshwater* series. The mass of freshwater limestone in Headon Bill belongs to this section. Brackish in the upper part, abounding in *Potamomya* and *Cyrena obovata*, at Cliff End they contain a cyrena (like *C. pulchra*). *Cerithium trizonatum* occurs here abundantly, and *Bulimus politus* and *Melania muricata* abound.

Middle Headons. "*The Headon intermarine or Upper marine formation.*"—At Headon Hill these deposits were deposited under brackish-water conditions, for, although *Ostrea*, *Cytherea incrassata*, *Nucula deltoidea*, *Natica depressa*, *Buccinum labiatum*, and other sea shells are common, the upper and lower beds abound in *Cerithium ventricosum*, *Cerithium concavum*, *Cerithium pseudocinctum*, *Neritina concava*, *Nematura*, *&c.* which are brackish or estuarine. A short distance further north, in Colwell Bay, the upper and lower beds contain brackish-water shells; *but the central part assumes a distinctly marine character.* *Ostrea velata*, S. Wood, is a characteristic species with numerous marine genera, many of which are of Barton types. This central part is known as the "*Venus bed*," from the presence of *Cytherea incrassata*. The marine character of the *Middle Headon beds* is still more strongly marked at Whitecliff Bay (22 genera). The lower portion of this series at Whitecliff Bay contains many Brockenhurst species, but at Colwell Bay we *have no evidence of characteristic species from this horizon*, or in *the western side of the island.*

Lower Headons, fresh and brackish-water series.

These beds are 70 feet thick in Totland Bay, and 40 feet thick in Whitecliff Bay.

They consist of fresh and brackish-water beds abounding in fossils resembling those of the upper division. *Unio Solandri* and *Cyrena cycladiformis* occur here and are characteristic.

At Headon Hill the thick bed of limestone in the Upper Headon is conspicuous in the cliffs, but it thins out rapidly towards the north and disappears in an easterly direction. The Lower Headon contains a much less thick limestone at Headon Hill, and it is represented by the band forming How Ledge between Colwell and Totland Bays. 120 species have been obtained from the Headon series; 104 mollusca, 9 crustacea, 4 annelids, and three plants, land, freshwater; and marine the fossils of the Headon fluvio-marine series, are $\frac{23}{74}$ gasteropoda; $\frac{16}{25}$ pelycipoda; polycipes 1, balanus 1, crustacea $\frac{6}{9}$, plantæ $\frac{2}{2}$, fish $\frac{2}{2}$.

Professor Judd, in a paper communicated to the Geological Society in May, 1880, on the Oligocene strata of the Hampshire basin, having reference to the beds at Headon Hill and Colwell Bay, in the Isle of Wight, endeavoured to show that the Colwell Bay marine beds are not, as has been hitherto supposed, the equivalents of those of Headon Hill and Hordwell Cliff, but that they occupy a distinct and much higher horizon in the Eocene series. Assuming this to be the case, a new classification and nomenclature for the Upper Eocene series of Britain was proposed by the author (*Quarterly Journal of the Geological Society*, vol. xxxvi. 1880.)

Professor Judd traced the history of previous opinion upon the succession of the Tertiary strata down to the time of Professor Edward Forbes and the Geological Survey, with the subsequent labours of Mr. Bristow. Edward Forbes confirmed the previous determinations of Professor Prestwich in his elaborate researches in the Isle of Wight Tertiaries. Forbes's life, however, was not spared to enable him to complete his researches in this division of the British strata; his attention was chiefly confined to the four uppermost Eocene members, or the Hempstead, Bembridge, Osborne, and St. Helen's, and the Headon beds. These divisions were accepted and worked upon as a basis by the Geological Survey. With regard to these strata, Forbes maintained, as almost all previous observers had done, that the beds at Colwell and Totland bays are on the same horizon as those at the base of Headon Hill and at Hordwell Cliff.

Professor Judd's view has been questioned and refuted by Messrs. Tawney and Keeping, in an elaborate paper also read before the Geological Society in May, 1881, (*Quarterly Journal of the Geological Society*, vol. xxxvii. 1881.) and in a subsequent communication to the Cambridge Philosophical Society in the same year, "On the Beds at Headon Hill and Colwell Bay in the Isle of Wight."

The importance of a correct reading and classification of these Middle Eocene strata in the Isle of Wight, and their correlation with beds of the same age in France, Belgium, and Germany, cannot be overlooked or over-estimated, and often as it has been attempted, the papers by the two above-named authors have still greatly added to our knowledge of the stratigraphy of the Eocene series of the Isle of Wight. It is impossible to dispute the validity of their researches and value of their sections. The publication of Mr. Judd's paper disputing the correctness of Forbes's work and that of the Geological Survey, and the proposal of a fresh classification, drew immediate attention to the labours of the older authors, but especially that by the Geological Survey—which was answerable for the latest, indeed the only known extended and complete analysis of the Upper Eocene strata of the Isle of Wight.

We owe a debt of gratitude to the late Mr. F. Edwards and Mr. S. V. Wood, for their valuable additions to our knowledge of the palæontology of the fauna of the fluvio-marine beds of the Hampshire basin. Since the publication of Professor Forbes's memoir upon the Isle of Wight, the molluscan fauna alone is at least three times as great as noticed by him, and since which the remarkable fauna of Brockenhurst in the New Forest, discovered by Mr. Edwards, has been carefully studied by Von Könen for the mollusca, and Dr. Duncan for the corals. These naturalists have shown the relation and agreement of this fauna with that of the Lower Oligocene in North Germany. This Brockenhurst fauna is also identical with certain strata at the base of the Middle Headon beds at Whitecliff Bay, in the Isle of Wight.

Professor Judd in his paper describes the stratigraphical position of the Colwell Bay and Headon Hill beds, and their relation to each other, pointing out what *he believed to have been an error on Forbes's part*, relative to the correlation of the "Venus bed" at two places, in what is really a continuous section, Edward Forbes and the Geological Survey having carefully and correctly determined that *only one set of marine* strata occurred between the two brackish or estuarine and freshwater series. This fact has been again most carefully worked out by Messrs. Tawney and Keeping, *leaving no doubt* as to the interpretation and accuracy of the work of Forbes and the Survey, and establishing upon a firmer basis the continuity and equivalency of the Colwell Bay and Headon Hill marine series, through the "Venus bed," all being stratigraphically and palæontologically the same. Professor Judd insists upon 250 feet of strata intervening between the Bembridge limestone and the marine band of Headon Hill, but Forbes and the Geological Survey in their section show less than one half of that thickness. Recent research confirms this view. At pp. 148–150, the author also endeavours to show that palæontological evidence is in accordance with, and as complete as the stratigraphical. This of course is based upon the belief that both are read or interpreted rightly. The comparison is between the collective fauna of Whitecliff, Colwell Bay, and Brockenhurst on the one hand, and Headon Hill and Hordwell on the other hand, but Messrs. Keeping and Tawney have shown the illogical nature of conclusions drawn from such an admixture of beds. Each bed should be compared separately.

Professor Judd (on pp. 150-164) correlates the British fluvio-marine strata with that of the Continent, adding at p. 153 of this paper a list of his so-called Brockenhurst species from Whitecliff Bay, Colwell Bay, Brockenhurst, and Lyndhurst, with those species common to the Barton beds below and Hempstead series above. This so-called Brockenhurst, but really Middle Headon fauna, numbers 84 genera, and 187 species (65 are MS. names). Four of the 13 corals of the Brockenhurst beds also occur in, or are representatives of the Oligocene strata of North Germany. This conclusion was arrived at by Dr. Duncan, independently of the work of Von Könen upon the mollusca in the same beds.[1] The author also prepared a list of the Hempstead or so-called Middle Oligocene fauna, in which no less than 40 genera and 101 species are named, 40 of these are manuscript names, by Mr. F. Edwards, thus reducing the described fauna to 61 species. The sub-division and nomenclature of the series is next given, and the author proposed to extend the "name of the Headon series, so as to embrace all the beds between the Barton and the Brockenhurst series, and to call all those strata said to belong to the zone of *Cerithium concavum* the Headon group," doing away with the smaller subdivision of Lower, Middle, and Upper. To all the beds between the Brockenhurst and Hempstead series Mr. Judd would apply the name Bembridge group; including the series both above and below the "Bembridge series of Edward Forbes, and also beds referred by him to the base of the Hempstead, the Osborne and St. Helen's, and to the Upper Headon." Such a proposal labours under the error of altogether failing to recognise the position which the Brockenhurst fauna occupies in this interesting series. Professor Judd in fact places the Brockenhurst beds not only above the Middle Headon, but above the Upper Headon and Osborne beds of Headon Hill. It occupies, however, in fact, a place at the base of the Middle Headon, as is well seen at Whitecliff Bay, and Brockenhurst itself.

This change in the nomenclature and classification has not met with approbation, and is strongly opposed by Messrs. Tawney and Keeping in their exhaustive paper, and by Mr. Lucas in his communication to the *Geological Magazine*, (*Geological Magazine*, decade ii. vol. ix.) Messrs. Keeping and Tawney elaborately defend the labours and views of the Geological Survey, giving a mass of evidence, both as to the order of the strata and the distribution of life forms, clearly showing that the relations of the whole group can be determined by examination of the continuity of the Colwell Bay and Headon Hill beds, and that the *brackish marine beds of Colwell Bay* correspond with the brackish marine beds of Headon Hill in every essential particular, being, in fact, one continuous and unbroken sequence, as laid down by the Geological Survey, and which the authors have again so clearly demonstrated in the text of their Memoir, and laid down in their clear and continuous section from Cliff End or Lynchen Chine to near Alum Bay Chine, and synthetically proved in their vertical sections.

The following general and condensed description or analysis of the Headon series of Holwell Bay and Headon Hill, as given by Messrs. Tawney and Keeping, will aid those wishing to examine the section, prior to reading or possessing themselves of the original paper in the *Quarterly Journal of the Geological Society*, vol. xxxvii. or that of Professor Judd, *loc. cit.*, Note 1.

Vertical Section at the North-east Corner of Headon Hill.—One hundred and ten feet of strata occur from the top of the Bembridge Limestone to the top of the Great Limestone (Upper Headon). The Brockenhurst series does not exist here. Not a single marine fossil occurs in that interval. Nor is there any bed having the least resemblance either lithologically or palæontologically to the Colwell Bay Venus bed.

The *Upper Headon* at Headon Hill measures 50 feet and contains the thick Lymnæan limestone (27 feet). The united or combined thickness of the Osborne and Upper Headon beds (Geological Survey) is 119 feet, *i.e.* adopting the top of the *Cerithium ventricosum* bed as the boundary. The Osborne beds at Headon Hill are below the Bembridge limestone and extend up to it, *so there is no room.*

The *Middle Headon.*—The uppermost and lower portions of the Middle Headon are brackish-water beds abounding in *Cerithium ventricosum*, *C. pseudocinctum*, *C. concavum*, *Neritina concava*, and *Nematuræ*. The beds or series in Headon Hill richest in *Cytherea incrassata* (Venus bed proper), exhibit identically the same fossils as at Colwell Bay.

Below the oyster band in grey sandy clays is the *Venus bed*, extremely rich in marine fossils. *Cytherea*, *Mya*, *Mactra*, *Corbicula*, *Nucula*, *Trigonocœlia*, *Fusus*, *Cancellaria*, *Voluta*, *Vicarra*, und *Natica* ; *Mya angustata* and *Cytherea incrassata* scattered throughout and abundant. The Middle Headon of Headon Hill is 32 feet thick. The Survey vertical section gives 35 feet for the same boundaries. The height of the Middle Headon above the sea level at the north-east end is 72 feet, and not below the sea level, as seems required on Professor Judd's theory.

Lower Headon.—The first bed is a Lymnæa limestone, and is the same well-known bed which forms the top of the Lower Headon in Warden Cliff. It is traceable to How Ledge, where it disappears below the sea, and clearly shows by its course that it is the How Ledge bed of Warden Cliff. Although this limestone is denuded from the top of the anticlinal curve between Weston and Widdick Chines, some of the lower beds are traceable the whole distance ; accordingly we can join on the section in Headon Cliff to that in Warden Cliff. This gives a continuous section and series of beds from the lowest seen of the Lower Headon, through the Middle and Upper Headon of Colwel Bay to the Bembridge limestone both north and south. There is therefore only one marine (*Middle Headon*) series lying between two freshwater series, or "the Lower and Upper Headon." The Rev. O. Fisher has discovered the Venus bed in the Totland Bay brickyard, some short distance above and

---

[1] A. von Könen on "The Correlation of the Oligocene Deposits of Belgium, Northern Germany, and the South of England." *Quarterly Journal of the Geological Society*, vol. xx. p. 97.

behind the top of the cliff, between the chines. This being the only part where it is missing from the cliff is proof of its continuity from Warden Cliff to the north-east corner of Headon Hill.

The authors describe in the most careful manner the Lower Headon beds of the cliffs between Weston and Widdick Chines, much of the space in which is hidden by grassy slopes, but the connection cannot be doubted.

The Lower Headon of Warden Cliff.—"The lowest beds of this series are seen below the Totland Bay Hotel at Weston Chine, and all are below the Venus bed. A remarkable feature in the lowest portion are five thin Lymnæan limestones, containing *chara* seeds. These five limestones at low water form five submarine ledges parallel to the great ledge at Warden cliff" (Warden ledge). Above these five beds and the sands containing *Potamomia* comes the concretionary calcareous sand rock which forms Warden Ledge. It crops out at the top of the cliff below the flagstaff of the coastguard station. Succeeding these is the Unio bed (*U. Solandri*) and associated with *Melania turritissima*. The How Ledge limestone succeeds and forms the summit of the Lower Headon series. This limestone is denuded away in the centre of Totland Bay, where we have evidence and may infer the summit of the anticlinal to be near the old wooden pier. The thickness of the Lower Headon in Warden cliff is 72 feet, and from that to 87 feet before reaching the yellow sands of the Upper Bagshot.

The whole of the cliffs between Weston and Widdick Chines are occupied solely and throughout by Lower Headon beds, and the Colwell Bay marine bed extends all through Warden point and cliff, where it rests upon, or is supported by the *How Ledge* limestone. Between Warden Battery and Weston Chine the Colwell Bay marine bed (Middle Headon) is maintained in all its integrity.

Middle Headon of Colwell Bay.—"The Neritina bed at the south-west end of the bay is well seen a little short of Colwell Chine. Above this comes the richest part of the 'Venus bed'—the fossil in which (*Cytheria incrassata*) strew the tumbled clays and commingle with recent shells on the shore." *Ostrea velata*, as at Headon Hill, is abundant above the part richest in Cytherea. This oyster occurs in vast abundance in the centre of the bay between Colwell and Bramble Chines, crowding out other fossils and forming a massive oyster bank about 20 feet thick. The Venus bed here is altered in character, and abundantly occurring with *Cytherea incrassata* are *Murex sexdentatus*, *Pisania labiata*, *Natica labellata*, *Nerita aperta*, *Cerithium variabile*, and *Ostrea velata*."

Upper Headon of Colwell Bay.—The horizon of *Cyrena Wightii* is a marked feature here, associated with *Corbicula obovata*; *Cerithium trizonatum* also occupies one horizon just below the buff-coloured Lymniæ limestone forming a narrow band with green clays: *Serpula tenuis* is equally characteristic, occurring at the same horizon both here and at Headon Hill, viz. in the *Upper Potamomya clay* just above the Lymnæa limestone.

PALÆONTOLOGICAL EVIDENCE

Having noticed the stratigraphical succession of the several divisions in the beds at Headon Hill and Colwell Bay, I now proceed to draw attention to the distribution of the fossils.

The authors of the paper have discussed the question as to whether the Colwell Bay has any more affinity with the Brockenhurst fauna than has the Headon Hill bed; and they compare the fauna both of the Colwell Bay and Headon Hill marine beds. This they do by separating in tabular form the fauna of all the localities which are to be compared together. The splendid collection of Tertiary fossils belonging to the late Mr. F. Edwards, and now in the British Museum, has formed the basis of their comparison, while their own researches have added occurences still more conclusive as to the correlation of species in the areas under examination and consideration. The authors obtained during their research in the Isle of Wight many species in the marine bed at Headon Hill which do not exist in the Edwards collection from that locality. "The test as to the contemporaneity of the beds in question is not to be obtained from the rarer forms only, but from a comparison of the commoner and more characteristic species." No less than fifty-eight species were obtained by the authors from the Middle Headon of two localities, Colwell Bay and Headon Hill, nineteen of which appeared in and came up from the Barton beds, and with seven exceptions all the fifty-eight forms came from both horizons.

It has been stated that the "*strata at Colwell Bay are of purely marine origin, while the so-called Middle Marine beds of Headon Hill and Hordwell Cliff are of totally different character.*" Messrs. Tawney and Keeping obtained from the marine series at Colwell Bay the brackish-water genera *Cerithium*, *Cyrena*, *Hydrobia*, *Lymnæa*, *Paludina*, *Planorbis*, *Melania*, and *Melanopsis*, although said to be found only at Headon Hill. It has also been stated that certain species of Cerithium are confined to Headon Hill, and do not occur in Colwell Bay, and that through this serious errors in our classification have been detected, as well as in the correlation of the strata under consideration.

The presence of *Cerithium concavum* in the Venus bed abundantly at Colwell Bay, and we may add from private information from Mr. Keeping that he has found it also at Whitecliff Bay in the same position, removes all doubt as to the non-occurrence of the zone in that locality. As has been stated, the species is not so common as at Headon Hill.

There is but one marine bed, and that is known only in the Middle Headon. The place of the Brockenhurst bed *is at the lowest horizon* in the Middle Headon, but it does not appear at Colwell Bay or anywhere in the west end of the island.

Middle Headon of Whitecliff Bay. It has been stated that the Colwell Bay bed is placed in the Brockenhurst, which is said to occupy a higher horizon than the Headon Hill and Hordwell marine bed. The true place of the Brockenhurst fauna in the Isle of Wight is confined *to one zone*, and that at the *base of* the the Middle Headon series, and *only at* Whitecliff Bay or in the New Forest.

The Geological Survey do not mention by name the Brockenhurst bed in their vertical section [Sheet 25] of Whitecliff Bay, as its peculiar fauna had not been recognised at that time. It is easily identified, however, in their section as the *basement bed* of their Middle Headon, the whole of which is given as 90 feet thick.

Brockenhurst Zone at Whitecliff Bay.—At the time the Geological Survey section was made, this bed at Brockenhurst was unknown, and its fauna undescribed. Subsequent observers have recognised the Brockenhurst fauna in the lowest bed (2 feet thick) of the Middle Headon at Whitecliff Bay. Sixty-nine species are known here, and 104 occur at Brockenhurst.

Affinities of the Brockenhurst Fauna.—If we take the whole Brockenhurst fauna, including the eighteen corals (special to the zone) we obtain a total of 151 species, of which from 74 to 81 pass up from Barton.

Messrs. Tawney and Keeping supply a list of 53 species from the Brockenhurst zone obtained from the Whitley Ridge Railway Cutting, New Forest. Fifty-one of these 53 forms have occurred in the 2-foot bed at Whitecliff Bay, 27 of which pass up from the Barton or Bracklesham beds.

The palæontological evidence therefore accords with the stratigraphical.

Relation of Colwell Marine to Brockenhurst Fauna.—Examination gives us 29 per cent. of Barton forms in the Colwell Bay bed. In the Brockenhurst bed the ratio was about 50 per cent., and in the Headon marine bed, 29 per cent. Examination also of the more characteristic Colwell and Headon marine fossils shows that these faunas are practically identical—and also shows that *only certain* Brockenhurst species occur at Colwell Bay, and not at Headon Hill. They are *Scalaria tessellata* and *Tellina affinis*, this latter a Barton form, while those occurring at Headon Hill, and *not at* Colwell Bay, are *Marginella æstuarina* and *Cardita paucicostata*, only "two in each case, which amounts to perfect equality." If we take into account those common to the Colwell and Headon marine beds, and not occurring at Brockenhurst, we find twenty-six species. It is therefore evident that the Brockenhurst fauna is not identical with that of the Colwell Bay bed, and not newer than that of Headon Hill.

Thus fossil as well as stratigraphical evidence shows that the Colwell Bay bed is identical with the Headon Middle Marine.

The same twofold proof demonstrates that the Brockenhurst bed, *where* present, lies at the base of the Middle *Marine* Headon beds, and immediately above the Lower Headon. This Brockenhurst bed is absent at Colwell Bay and Headon Hill, but occurs at Whitecliff Bay, Brockenhurst, and Lyndhurst.

The proposal by Prof. Judd to extend the name of the Headon series so as to include all the beds between the Barton and Brockenhurst series, and call them the "Headon Group," would cause great inconvenience. The term Middle Headon, based as it is on the classical work of Edward Forbes, is clear and definite. Again, it would entail the abandonment of the names Upper and Lower Headon also; and the non-occurrence of the Brockenhurst series, or its representative, in Colwell Bay admits of no recognition on the west side of the island, and therefore the classification would be based upon a defective appreciation of the beds.

Von Könen, in 1864, justly correlates the fauna, and since then, in 1866, the coral fauna has been described by Dr. Duncan.

Messrs. Tawney and Keeping, in their paper on the beds at Headon Hill and Colwell Bay in the Isle of Wight, uphold the work done by the Geologinal Survey, maintaining the correctness and integrity of the two Survey Memoirs, and the horizontal and vertical sections of the Tertiary beds of the Isle of Wight. Prof. Judd differs from the identifications and stated succession of the beds in Totland and Colwell Bays. He *introduces two new series at Headon Hill*, a marine and a freshwater (?) in addition to those which have been universally accepted for the last twenty-five years (*Quarterly Journal of the Geological Society*, vol. xxxvi.).

The sections prepared by Prof. Judd also differ very considerably from that of the Geological Survey, or those lately prepared by Messrs. Keeping and Tawney, during their late examination of the beds under notice. These are the marine series known as the *Middle Headon* or *Middle Marine*. Prof. Judd places them at the sea level near Widdick Chine. Consequently, between the *top of the marine bed* and that of *the Bembridge limestone*, there would be, on Prof. Judd's theory, 250 feet of beds, such being the altitude of the cottage on the Warren which marks the summit of the Bembridge limestone. This thickness must, however, be reduced by 100 or 105 feet, which is the altitude of the top of the Middle Headon at this point. This 105 feet of beds, or *another* freshwater and *another* marine have no existence; they can only be accounted for by counting the Lower and Middle Headon twice over. Now the only marine beds are those of the Middle Headon, inclosed between the altitudes of 70 feet above the sea *level;* the others are all fresh water.

The point wherein Prof. Judd's section differs from the Survey, and that of the authors, arises from the belief that a *second marine series*, termed the "Brockenhurst series," with another freshwater below, in all 105 feet, is intercalated above the *Upper Headon*—these two believed new formations having that portion of the section allotted to them which is occupied by the freshwater *Osborne marls* and part of the Upper Headon. It must be remembered that there is no positive evidence of the existence of this second marine (*Brockenhurst*) series *at the* spot where the Geological Survey place the *Osborne marls.* Careful examination fails to reveal these said to be additional beds. It is clear, therefore, that no bed having the peculiar fauna of the Brockenhurst bed occurs at the west end of the island; its place too, if found, would be at the *base of the* Middle Headon, and not *above the Upper*, where it has been wrongly assigned. Messrs. Keeping and Tawney, in their paper, object to the correlation of the *Brockenhurst* with the Colwell Bay bed—which is identical with the marine (Middle Headon) bed of Headon Hill. Thus the 105 feet of strata have no existence.

The Middle Headon, which is denuded away from the top of the cliffs in the centre of Totland Bay between Western and Widdick Chines, has been discovered in the Totland Bay brickyard, which lies a little inland of this portion of the cliff, thus conclusively showing that this bed was continuous above the top of the cliff, consequently linking the Warden Cliff exposure to that of Headon Hill. They are visibly and absolutely continuous with those of Colwell Bay.

Palæontological Evidence.—The equivalency of the Colwell Bay and Brockenhurst beds is a point to be definitely settled. Most careful lists of fossils have been prepared from collections made both from the Middle Headon at Colwell Bay, and Headon. We find that out of fifty-seven species at Colwell Bay, fifty-three occur in the Middle Marine of Headon Hill, or 93 per cent. This clearly proves the identity of the horizon in the two localities.

The well-known shells *Cerithium concavum* and *C. ventricosum* occur both in Colwell Bay and Headon Hill, and on the same horizons. *C. concavum* appears to have a less restricted range at Headon Hill than *C. ventricosum*, occurring abundantly there through the greater part of the Middle Headon series. It has also been found in the "Venus bed" of Colwell Bay. Thus both stratigraphical and palæontological evidence are in harmony. All evidence tends clearly and conclusively to show that there is *only one marine series* in this section, viz. the Middle Headon of Edward Forbes, which is interstratified between the freshwater Lower and freshwater Upper Headon; while there is no evidence of the Brockenhurst bed occurring anywhere in the west of the island.

Whitecliff Bay and the New Forest.—The Brockenhurst bed was recognised at Whitecliff Bay by the Rev. O. Fisher in 1864, where it occurs in the lowest 2 feet of the Middle Headon series. No less than 70 species have been collected here out of 104 known at Brockenhurst. Many species are peculiar to it, but all are identical with those of the well-known section in the railway cutting near Brockenhurst. Many species are confined to this horizon *and do not pass up into* the "Venus bed." Thus the Brockenhurst fauna at Whitecliff Bay number 70 species, at Brockenhurst 104, and of these only 18 occur in the Middle Marine beds of Colwell Bay, or are common to Whitecliff Bay and type locality. Eighty-three Barton or Bracklesham species pass up, 25 to the Middle Marine of Colwell Bay, and 36 to the Brockenhurst bed of Whitecliff Bay, or these two localities yield the above number of Bartonian forms. To still further illustrate the value of the *Middle Headon* series of the Isle of Wight and elsewhere, I may mention certain characteristic fossils that occur in several zones. The "*Venus* bed" of the Geological Survey is about 30 feet thick at Colwell Bay, Headon Hill, and Whitecliff Bay, and contains the following well-marked shells, *Murex sexdentatus*, *Melania fasciata*, *Cerithium duplex*, *C. ventricosum*, *C. concavum*, and *Nerita aperta.* Shells characteristic of the Brockenhurst bed and confined to it are *Voluta suturalis*, *Leiostoma ovatum*, *Pecten bellicostatus*, *Modiola nysti*, *Cyprina nysti*, and *Cytherea solandri*, var. *attenuata.* In the Roydon zone occurs *Voluta geminata*, and nowhere else in England. *Pleurotoma transversaria*, *P. subdenticulata*, *Cardita deltoidea*, and *Protocardium hantoniense* are in both the Roydon and Brockenhurst zones, but not known in the Venus bed. Certain species range through the Middle Headon series and occur nowhere else. These are *Pisania labiata*, *Pleurotoma headonensis*, *Cancellaria muricata*, *C. elongata*, *Leda propinqua*, *Cytherea suborbicularis*, *Psammobia æstuarina*, and *Corbicula obovata.* The Brockenhurst zone is restricted to the lower 2 feet of the Middle Headon, and it lies immediately on the eroded surface of the Lower Headon. An error certainly has been committed in the New Forest Section, in assigning the place of the Brockenhurst series above the Middle Marine or Middle Headon. This is at variance with facts at Brockenhurst and Whitecliff Bay, and this misapprehension as to the stratigraphical position of the Brockenhurst bed refutes the theory as to the occurrence of this bed high up in the Headon Hill. It is not in existence there.

With reference to the affinities of the Brockenhurst fauna it has been stated that "nearly one-third of the Hordwell and Headwell Hill marine shells are Barton forms, and not more than one-fifth of those occurring at Brockenhurst, Colwell Bay, and Whitecliff Bay, are found at Barton." We should not expect the *Venus Bed* or *Middle Marine* would have more Barton species than the Brockenhurst Bed, seeing that the former occupies a higher zone in the Middle Headon series. The percentage of Barton forms, according to Mr. Tawney, in the Whitley Ridge bed, is 42 per cent.; a lower proportion than at Whitecliff Bay, arising from the number of corals being special to the Whitley locality. At Whitecliff Bay the Barton group has 52 per cent., and the proportion of Barton forms *from all the Brockenhurst* localities, including the Roydon zone, is 48 per cent., and the percentage of the Barton forms in the Middle Headon of Headon Hill is found to be 29 per cent.; the conclusion, therefore, from fossil evidence is that the Headon Hill marine bed is later in age, and higher stratigraphically than the Brockenhurst bed, the proportion of Barton forms in the latter being nearly 50 per cent., and not one-fifth, as stated. The result is in strict accordance with their stratigraphical positions. It is equally important to test by fossil evidence whether the Colwell Bay Venus bed (Middle Headon) is more nearly related to the Brockenhurst than is the Headon Hill bed. In Colwell Bay the observed Barton forms are 29 per cent. in common, and the same percentage in the Headon Hill bed, while in the Brockenhurst bed they were 48 per cent. To test still more the proof from palæontological evidence, it is stated, on the same authorities, that there are only *two species in each case* common to either Colwell Bay, or Headon Hill and Brockenhurst, and not occurring at Barton; while there are *twenty-six species common to Colwell Bay and Headon Hill*, and not occurring at Brockenhurst. It is clear, therefore, from all fossil and physical or stratigraphical evidence, that the position of the Brockenhurst bed has been misconceived, and it would be fatal to re-name the whole series of strata hitherto so well known and well determined as the Middle Marine or Middle Headon of the Isle of Wight, and call it the "Brockenhurst series." The classification and nomenclature of the Geological Survey must therefore be restored and maintained, all recent examination having strengthened the previous labours of Forbes and Bristow, and the later researches of Messrs. Tawney and Keeping, have still more firmly established the succession and correlation of the Middle Headon series of the island, and affording a basis for further research and analysis for the "Anglo-Parisian or Hampshire Tertiary Basin."

Mr. Tawney prepared an important paper upon the *Upper Bagshot Sands of Hordwell Cliff*, which was read before the Cambridge Philosophical Society, and published in their *Proceedings*. The object of the communication was to discuss the affinities of the *Bagshot* series with a view to their classification, and also to endeavour to show their correlation and equivalents in the Paris basin. "All observers are agreed as to the actual position of the sands being below the fresh-water Lower Headon. Edward Forbes and the Geological Survey distinctly ally it to the Marine Bagshot beds. They place it in the Middle Eocene Bagshot series, terming it Upper Bagshot (*instead of Headon Hill Sands*). Forbes noticed its containing Barton species at Whitecliff Bay. This leads to or shows its affinity to Barton beds. Dumont favoured a similar classification in his essay, and in his table the Headon Hill sands are grouped with the Barton clay as being respectively equivalent to the upper and lower divisions of the *Belgian Laekenian*, while the Headon Hill limestones and marls are placed *Tongrien*. Lately these views have been questioned by the author of the "Oligocene Strata of the Hampshire Basin," in the *Quarterly Journal of the Geological Society*, vol. xxxvi., who regards them as constituting the lowest member of the Headon group, stress being laid upon the occurrence of *Cerithium concavum* as a test. The author also places the whole of the Upper Bagshot sands and the Lower Middle Headon beds as the equivalents of the Mortefontaine sands, placing them *above* the St. Ouen limestone; these St. Ouen beds representing perhaps the Osborne, and all three Headon divisions, which come above the Mortefontaine beds. *Cerithium concavum* is said to occur both in the Bagshot and Headon series. Careful research and examination shows that the shell in question is Lamarck's *C. pleurotomoides* in the one case, and not *C. concavum*, which species has evidently been confounded with the Lamarckean shell. Examination of equivalent beds in France by Mr. Tawney, and the researches of Prof. Hebert and M. Munier-Chalmas clearly show that the Mortefontaine sands *do not contain Cerithium concavum*, the shell so common on that horizon being *C. pleurotomoides* Lamk." Comparison of the Headon shell with those brought from near Mortefontaine shows that the Long Mead End species agrees with the French form. It would appear that there is much greater parallelism between the French and English series than we have hitherto expected. The Mortefontaine sands are the upper part of the Sables de Beauchamp, representing our Barton beds; above this comes the Calcaire de St. Ouen, chiefly of freshwater origin. Connected with the St. Ouen limestone are sands and marls, containing at the top and bottom *Cerithium concavum* abundantly.

The St. Ouen period, therefore, without doubt represents our Headon series. "In our Hampshire basin the freshwater and marine condition in the Headon series are not in the same order as in the St. Ouen beds." "The marine facies in Hampshire, with *C. concavum*, comes between the freshwater Lower and Upper Headon deposits, near Montjavoult; the bulk of the freshwater limestone is in the centre or between two deposits with this *Cerithium concavum*." "In the Paris basin, therefore, the zone of *C. concavum* is not connected with the zone of *C. pleurotomoides*, but comes immediately above it." Thus *C. concavum* characterises the Middle Headon of Colwell Bay and Hordwell, while *C. pleurotomoides* is found only in the Upper Bagshot of Long Mead End. That the Long Mead End sands, and those of Mortefontaine are equivalents few can doubt. Both succeed or constitute the uppermost portion of the Barton beds, and 25 per cent. of the fossils are in common. These affinities show that the term Upper Bagshot sands is the most appropriate, and expresses the relationship of these sands, since the Barton and Bracklesham beds together are usually considered as the equivalents of the Middle Bagshots. The author believes, therefore, that it would be wrong to reject Edward Forbes's name of "Upper Bagshot" for the Long Mead End sands, and accept in place of it the older term of Headon Hill sands.

Mr. A. H. S. Lucas, M.A., in his concise but valuable paper "On the Headon Beds of the Western Extremity of the Isle of Wight" (*Geological Magazine*, n.s. decade ii. vol. ix.), correctly states, upon referring to the recent "answer to the present questioning of the hitherto accepted correlations of the beds of the Lower fluvio-marine Tertiaries of the Isle of Wight and South Hants, that it is obviously impossible for foreign geologists to institute useful comparisons between British and foreign subdivisions so long as we in England are quite at variance on the stratigraphical and palæontological *facts* of the beds in question.[1]

"The general relation of the whole group can only be satisfactorily determined after the primary question of the continuity or discontinuity of the Colwell Bay and Headon Hill beds is settled. At present there are two very definite, yet different views, having a perfectly distinct issue; first, that *the brackish-marine beds of Colwell Bay correspond to the brackieh-marine beds of Headon Hill which have been seen*; or, secondly, *that they correspond to some higher marine beds which have not been seen*." Both these views and arguments are now fairly before those competent to judge. In 1880, however, Prof. Judd, in his paper "On the Oligocene Strata of the Hampshire Basin" (*Quarterly Journal of the Geological Society*, vol. xxxvi., p. 137, &c.), questioned and denied the succession as determined by Forbes and the Survey; this paper dealt with strata or higher marine beds, stated above by Mr. Lucas as "*not having been seen*." On the other hand, in 1881, Messrs. Tawney and Keeping brought to bear upon the question a mass of evidence in support of the work of Edward Forbes and the Survey (*Quarterly Journal of the Geological Saciety*, vol. xxxvii. p. 85), showing conclusively the identity and continuity of the Colwell Bay and Headon Hill fluvio-marine beds. Still more recently, however, Prof. Blake (*Proceedings* of the Geological Association, vol. vii.) has "advanced an entirely new correlation, adducing stratigraphical evidence in its favour." His observations do not agree in certain cases either with those of Prof. Judd or Messrs. Tawney and Keeping. It is hoped, however, by or through evidence at the present meeting, that the question of the succession will be finally determined. Mr. Lucas does not attempt any solution as to the relation of these beds at Colwell Bay and Headon Hill to the deposits exposed at Hordwell, Brockenhurst, or Whitecliff Bay; they do not concern the succession. But the standard or synthetic sections at different localities, like those prepared by Messrs. Tawney and Keeping, have tended to clear up the succession, fully testing the continuity of these beds under dispute under their several aspects along the plane of deposition. This independent mode fully bears out the exact work of the Survey, showing differences in degree as regards accumulation, yet continuity as regards succession. Mr. Lucas gives measured sections of the freshwater beds, and the brackish marine series (p. 99 *loc. cit.*), which confirm the work of the above authors.

The Headon beds were long ago "measured by Dr. Wright, lately by the authors just quoted, and the Osborne series by Edward Forbes, and the main divisions are so conspicuous that there can be no doubt about the succession." A third paper upon the fluvio-marine beds of the Isle of Wight was read before the Geologists' Association in June 1881, under the title, "On a Continuous Section of Oligocene Strata from Colwell Bay to Headon Hill" (*Proceedings* of the Geological Association, vol. vii.), by Prof. J. F. Blake, M.A., F.G.S. The author contends for a difference between the faunæ of the *Colwell Bay* beds and those of *Headon Hill*, and states that the "fauna of the so-called Oligocene group is chiefly to be found in the '*Venus bed*'' of Colwell Bay; but the assumed *other* 'Venus bed' at Headon Hill contains rather the fauna of the uppermost Eocene, or zone of *Cerithium concavum*." The question, however, turns upon the identity of the two so-called Venus beds. In other words, the Colwell Bay "Venus bed"

---

[1] A concise and important paper on "The Classification of the Tertiary Deposits," by Prof, Judd, appeared in the *Popular Science Review* for 1880, accompanied by a table showing the correlation of the Lower Tertiary strata of Western Europe. The Headon and Brockenhurst beds are placed under the Lower Oligocene, and the Bembridge and Hempstead series under the Middle Oligocene.

is said by the author to have one fauna, and the Headon Hill Venus bed another. This determination I hold to be untenable, all fossil and physical evidence being to the contrary, and show that they are one and the same bed. On both sides of Bramble Chine the "*Venus bed*" is fully developed. Mr. Blake calls it the "*oyster bed.*" Below these come thin bands of stratified marl, with abundance of *Cerithia* and *Cyrena* (not Cyclas, as stated). The Widdick Chine sands can be no other than the Headon Hill sands, and not the Upper Bagshots. The altitude of these sands above the sea Mr. Blake estimated at 100 feet; this is certainly too great an elevation, 70 feet being the received measurement by independent observers. Such difference, if it existed, would alter the reading and sequence of succeeding and higher beds in the section. The author seems to have omitted the *Triginocœlia* and *Neritina* bed immediately above the How Ledge limestone and below the thick oyster band. These correspond with the Warden Cliff section, and determine continuity of deposition, or are a confirmation of the identity of the beds. This is a crucial point in the continuity and equivalency of the marine series in Totland and Colwell Bays. The *Trigonocœlia* bed here is on the same horizon as in Warden Cliff and Colwell Bay, associated with *Cerithium pseudocinctum*, *Melanopsis fusiformis*, and *Natica labellata*, &c. The lower or Neritina concava bed, with *Melanopsis fusiformis* and *Corbicula ovata*, occurs also in the same position near the base of the series at Warden Cliff and Colwell Bay. "This can only be explained by admitting that the *Marine series in Totland Bay and Colwell Bay are identical.*" The occurrence of "*Cerithium ventricosum* at the top, and the *Neritina* [*N. concava*] and *Trigonocœlia* [*T. deltoidea*] at the base—identical in physical and fossil characters, are strong presumptive proof of this." It is extremely doubtful if *Ceritheum margarataceum*, mentioned on p. 6 of Mr. Blake's paper, occurs in the Colwell Bay section, or in the western area of the Isle of Wight—the *Ceritheum cinctum* is really *C. pseudocinctum*, and *Cyclas obovata* should be *Cyrena obovata*. The genus *Cyclas* does not occur. In correlation these are important items, especially with a continental fauna. It will also be found that the oyster beds do not rest immediately on the How Ledge limestone as asserted—the *Trigonocœlia* and *Neritina* beds intervene, and as at Colwell Bay, determine or prove the succession and identity of the series. At pp. 156-7 Mr. Blake remarks upon the similarity of the succession of the Colwell Bay beds with those of Headon Hill, and is "*tempted to come to the conclusion*" that the two "Venus beds are identical;" [they have always been so believed and recognised]; he at the same time states that "it would be absurd to argue that they are identical because they contain similar common fossils," when it has been "determined by Prof. Judd that the faunas are remarkably distinct." We have no other method whereby to determine the age and synchronism of deposits except through organic remains, and the faunæ of the "Venus beds" at both localities are to me identical, and Prof. Blake depends upon fossil evidence all through his paper, yet evidently he has not carefully examined the more complete fauna of the "Venus bed" at both localities. In another paragraph, on p. 157, the author states the proposition "that the Colwell Bay 'Venus bed' is not certainly identical with that at Headon Hill, but may occupy a higher horizon. Mr. Blake suggests that the Headon Hill bed corresponds to the series intervening between the Colwell Bay bed and the How Ledge limestone; and that the Colwell Bay bed corresponds to the slightly fossiliferous sands immediately *below the* Headon Hill limestone. This position or suggestion certainly cannot be received. In this case the so-called two "Venus beds" would be superposed on each other and nothing to separate them. The sands referred to are those at the base of the Upper Headon series, and are freshwater, for they contain Unio. Again, Prof. Blake's suggestion would thus place the Colwell Bay "Venus bed" below the Great Limestone, whereas Prof. Judd in his paper would place it above.

The author does not find any equivalents of the Colwell Bay opster beds *above the* Headon Hill limestone at Headon Hill, indeed that would be impossible, for they are indisputably the Osborne marls of Prof. Forbes, and capped by the Bembridge limestone.

As regards the terms Eocene and Oligocene, and their relation to each other, and the correlation of British strata and fossils with that of Germany, &c., it is far too intricate a question to be passed over, although without doubt the fluvio-marine strata of the Hampshire basin will ere long receive critical supervision with reference to similar deposits on the Continent. So far back as December, 1863, Herr Adolf von Könen prepared and read his paper on the correlation of Oligocene deposits of Belgium, North Germany, and the South of England, and endeavoured to show that in Britain we had an assemblage of fossils in our so-called Middle Eocene at Brockenhurst, Lyndhurst, and Roydon in the New Forest, that could be stratigraphically correlated with beds of the same age termed Oligocene in Northern Germany. The author believed that these Brockenhurst beds were of the same age as the Middle Headon beds of Colwell Bay and Whitecliff Bay. This view has led to much controversy, arising from the fact that no Brockenhurst species occur in Colwell Bay. The rich cabinet of Mr. F. Edwards then afforded von Könen every facility for the comparison and determination of the species occurring common to Britain and Germany. Beyrich established the name Oligocene for the fossils of this age in Germany. The Lower Oligocene is well developed, with a true marine fauna, in Belgium, near Tongres (North of Liege), and in the North of Germany, between Magdeburg, Bernberg, Egeln, and Helmstädt (near Brunswick). This Lower Oligocene contains 700 species of mollusca besides other groups. The most characteristic of these, the author asserts, are found at Brockenhurst, and in Mr. Edwards's cabinet, fifty-six species occur, twenty-one of which are Barton clay forms, and forty-three of the fifty-six species occur in the Lower Oligocene of Germany.

SECTION D

BIOLOGY

Department of Anthropology

ADDRESS BY W. BOYD DAWKINS, M.A., F.R.S., F.G.S., F.S.A., PROFESSOR OF GEOLOGY AND PALÆONTOLOGY IN THE VICTORIA UNIVERSITY, VICE-PRESIDENT OF THE SECTION.

On the Present Phase of the Antiquity of Man—In taking the chair in this department of the biological section of the British Association, two courses lie open before me. I might give an address which should be a history of the progress of anthropology during the last year, or I might devote myself to some special branch. The swift development of our young and rapidly growing science, which embraces within its scope all that is known, not merely about man, but about his environment, in present and past times, renders the first and more ambitious course peculiarly difficult to one, like myself, labouring under the pressure of many avocations. I am therefore driven to adopt the second and the easier, by choosing a subject with which I am familiar, and which appears to me to be appropriate in this place of meeting. I propose to place before you the present phase of the inquiry into the antiquity of man, and to point out what we know of the conditions of life—though our knowledge of them is imperfect and fragmentary—under which man has appeared in the Old and in the New Worlds. The rudely chipped implements left by the primeval hunters in the beds of gravel of Hampshire and Wiltshire, and along the shores of Southampton Water and elsewhere, are eloquent of the presence of man in this district, at a time when there was no Southampton Water, and the elephant and the reindeer wandered over the site of this busy mart for ships; when the Isle of Wight was not an island, and the River-drift hunter could walk across from Portsmouth to Cowes, with no obstacle excepting that offered by the rivers and morasses. I propose to enter upon the labours of Prestwich, Evans, Stevens and Blackmore, Codrington, Read, Brown, and other investigators in this country, and to combine the results of their inquiries with those in other countries, and with some observations of my own which I was able to make in 1880, during my visit to the United States.

The Limitation of the Inquiry.—The most striking feature in the study of the Tertiary period is the gradual and orderly succession of higher types of Mammalia, so well defined and so orderly, that I have used it as a basis for the classification of the Tertiary period. We find the placental mammals becoming more and more specialised as we approach the frontier of history. The living orders appear in the Eocene, the living genera in the Meiocene, a few living species in the Pleiocene, and the rest in the Pleistocene. The characteristics of this evolution of living forms may be summed up in the following table:—

Definition of Tertiary Period by Placental Land Mammals.

VI. Historic ; in which the events are recorded in history.	Events included in history.	Founded on discoveries, documents, refuse - heaps, caves, tombs.
V. Prehistoric ; in which domestic animals and cultivated fruits appear.	Man abundant ; domestic animals, cultivated fruits, spinning, weaving, pottery - making, mining, commerce ; the neolithic, bronze, and iron stages of culture.	Camps, habitations, tombs, refuse-heaps, surface accumulation, caves, alluvia, peat-bogs, submarine forests, raised beaches.
IV. Pleistocene ; in which living species of placental mammals are more abundant than the extinct.	Man appears ; *Anthropidæ* ; the palæolithic hunter ; living species abundant.	Refuse-heaps, contents of caves, river deposits, submarine forests, boulder – clay, moraines, marine sands, and shingle.
III Pleiocene ; in which living species of placental mammals appear.	Living species appear ; apes, *Simiadæ*, in Southern Europe.	Fresh - water and marine strata ; volcanic débris (Auvergne).
II. Meiocene ; in which the alliance between living and placental mammals is more close than before.	Living genera appear ; apes, *Simiadæ*, in Europe and North America.	Fresh - water and marine strata ; volcanic débris (Auvergne) ; lignites.
I. Eocene ; in which the placental mammals now on earth were represented by allied forms belonging to existing orders and families.	Living orders and families appear ; lemurs (*Lemuridæ*) in Europe and North America.	Fresh - water and marine strata ; lignites.

The orders, families, genera, and species in the above table, when traced forward in time, fall into the shape of a genealogical tree, with its trunk hidden in the Secondary period, and its branchlets (the living species) passing upwards from the Pleiocene, a tree of life, with living Mammalia for its fruit and foliage. Were the extinct species taken into account, it would be seen that they fill up the intervals separating one living form from another, and that they too grow more and more like the living forms as they approach nearer to the present day. It must be remembered that in the above definitions the fossil marsupials are purposely ignored, because they began their specialisation in the Secondary period, and had arrived in the Eocene at the stage which is marked by the presence of a living genus—the opossum (*Didelphys*).

It will be seen, from the examination of the above table, that our inquiry into the antiquity of man is limited to the last four of the divisions. The most specialised of all animals cannot be looked for until the higher Mammalia by which he is now surrounded were alive. We cannot imagine him in the Eocene age, at a time when animal life was not sufficiently differentiated to present us with any living genera of placental mammals. Nor is there any probability of his having appeared on the earth in the Meiocene, because of the absence of higher placental mammals belonging to living species. It is most unlikely that man should have belonged to a fauna in which no other living species of mammal was present. He belongs to a more advanced stage of evolution than the mid-Meiocene of Thenay, as may be seen by a reference to the preceding table. Up to this time the evolution of the animal kingdom had advanced no farther than the Simiadæ in the direction of man, and the apes then haunting the forests of Italy, France, and Germany, represent the highest type of those on earth.

We may also look at the question from another point of view. If man were upon the earth in the Meiocene age, it is incredible that he should not have become something else in the long lapse of ages, and during the changes in the conditions of life by which all the Meiocene land Mammalia have been so profoundly affected, that they have been either exterminated, or have assumed new forms. It is impossible to believe that man should have been an exception to the law of change, to which all the higher Mammalia have been subjected since the Meiocene age.

Nor in the succeeding Pleiocene age can we expect to find man upon the earth, because of the very few living species of placental mammals then alive. The evidence brought forward by Professor Capellini, in favour of Pleiocene man in Italy, seems both to me and to Dr. Evans unsatisfactory, and that advanced by Professor Whitney in support of the existence of Pleiocene man in North America, cannot in my opinion be maintained. It is not until we arrive at the succeeding stage, or the Pleistocene, when living species of Mammalia begin to abound, that we meet with undisputable traces of the presence of man on the earth.

The Pleistocene Period.—As a preliminary to our inquiry we must first of all define what is meant by the Pleistocene Period. It is the equivalent of the Quaternary of the French, and the Postpleiocene of the older works of Lyell, and it includes all the phenomena known in latitudes outside the Arctic Circle, where ice no longer is to be found, under the name of glacial and interglacial. It is characterised in Europe, as I have pointed out in my work on "Early Man in Britain," by the arrival of living species, which may be conveniently divided into five groups, according to their present habitats. The first consists of those now found in the temperate zones of Europe, Asia, and North America. It includes the following animals:—

Mole, musk shrew, common shrew, mouse, beaver, hare, pika, pouched marmot, water-vole, red field-vole, short-tailed field-vole, Continental field-vole, lynx, wild cat, wolf, fox, marten, ermine, stoat, otter, brown bear, grisly bear, badger, horse, bison, urus, saiga antelope, stag, roe, fallow-deer, wild boar.

The second consists of animals of arctic habit:—

Russian vole, Norwegian lemming, arctic lemming, varying hare, musk sheep, reindeer, arctic fox, glutton.

The third is composed of those which enjoy the cold climate of mountains:—

The snowy vole, Alpine marmot, chamois, and ibex.

These animals invaded Europe from Asia, and as the cold increased, the temperate group found their way into Southern Europe and Northern Africa, while the arctic division pushed as far south as the Alps and Pyrenees.

The fourth group of invading forms is represented by animals now only found in warm countries:—

Porcupine, lion, panther, African lynx, Caffre cat, spotted hyena, striped hyena, and African elephant.

This group of animals is found as far to the north as Yorkshire, and as far to the west as Ireland. Among the southern animals, too, must be reckoned the hippopotamus, which lived as far north as Britain in the Pleiocene age, and in the Pleistocene occurs in caves and river deposits, in intimate association with some arctic species, such as the reindeer.

The fifth group is composed of extinct species, hitherto unknown in Europe in the Pleistocene age, such as—

The straight-tusked elephant, mammoth, the pigmy elephants, woolly and small-nose rhinoceroses, the Irish elk, pigmy hippopotamus, and the cave bear.

The question as to which of these groups the River-drift man belongs must be deferred till we can take a survey of the evidence elsewhere.

The early Pleistocene division is characterised by the presence of the temperate and southern species in Britain ; the middle stage by the presence of the arctic, but not in full force ; and the late Pleistocene by the abundance of arctic animals, not only in Britain, but on the Continent as far as the Alps and Pyrenees, and the lower valley of the Danube.

The Early Pleistocene Forest and Mammals of East Anglia.—The first view which we get of the Pleistocene Mammalia in this country is offered by the accumulations associated with the buried forest of East Anglia. It extends for more than forty miles along the shores of Norfolk and Suffolk, from Cromer to Kessingland, passing into the cliff on the one hand and beneath the sea on the other. The forest was mainly composed of sombre Scotch firs and dark clustering yews, relieved in the summer by the lighter tinted foliage of the spruce and the oak, and in the winter by the silvery gleam of the birches, that clustered thickly with the alders in the marshes, and stood out from a dense undergrowth of sloes and hazels. Among the animals living in this forest of the North Sea were species which haunted the valleys of the upper Seine at the time, such as the southern elephant, the Etruscan rhinoceros, the deer of the Carnutes, extinct horses, and the large extinct beaver. There were in addition the shaggy-maned mammoth, the straight-tusked elephant, and the big-nosed rhinoceros. The stag, the roe, the Irish elk, were in the glades, Sedgwick's deer, with its many-pointed antlers, the verticorn deer, and the gigantic urus. The undergrowth formed a covert for the wild boar, and for beasts of prey, many in species and formidable in numbers. The cave bear, the hugest of its kind, the sabre-toothed lion, the wolf, the fox, and the wolverine. Among the smaller animals were to be noted the musk shrew, the common shrew, and a vole. In the trees were squirrels. Under foot the moles raised their hillocks of earth, and from between the lofty fronds of the Osmund royal beavers were to be seen building their lodges, and the hippopotamus as he emerged from the water and disappeared in the forest. Out of thirty species identified, no less than seventeen are living in some part of the world, and we have there obviously the stage in the evolution of mammalian life when the living species were becoming more abundant than the extinct. We may note, too, the absence of arctic animals in this fauna, more particularly of the reindeer.

The presence of these animals in Norfolk and Suffolk implies that at this time Britain was united to the Continent, and the presence of fossil species found in France indicate a southern extension of land in the direction of the Straits of Dover. The forest covered a large portion of the area of the North Sea, and in all probability the Atlantic seaboard was then at the 100-fathom line of the west coast of Ireland.

No traces of man have as yet been discovered in these deposits, although the large percentage of living species of higher Mammalia indicates that the geological clock had struck the hour when he may be looked for.

The Appearance of the River-drift Hunter at Crayford and Erith.—The living species in the forest bed are to be looked upon as an advanced guard of a great migration of Asiatic and African species, finding their way into North-western Europe, over the plains of Russia, and over barriers of land connecting Northern Africa with Spain by way of Gibraltar, and with Italy by way of Malta and Sicily (see "Cave Hunting and Early Man").

In the course of time the other living species followed, and extinct species became more rare. In the deposits, for instance, of the ancient Thames, at Ilford and Grays Thurrock in Essex, and at Erith and Crayford in Kent, out of twenty-six species, six only belong to extinct forms—the new-comers comprising the lion, wild cat, spotted hyena, and otter, the bison, and the musk sheep. A flint flake discovered by the Rev. Osmund Fisher, at Crayford, and a second discovered by Messrs. Cheadle and Woodward, at Erith, prove that man was present in the valley of the Thames at this time; while the more recent discoveries of Mr. Flaxman Spurrell indicate the very spots where the palæolithic hunter made his implements, and prove that he used implements of the River-drift type, so widely distributed over the surface of the earth. The arctic animals at this time were present, but not in full force, in Southern Britain, and the innumerable reindeer which characterise the later deposits of the Pleistocene age had not, so far as we know, taken possession of the valley of the Thames.

To what stage in the Pleistocene period are we to refer these traces of the River-drift hunter? The only answer which I am able to give is that the associated animals are intermediate between the Forest-bed group and that which characterises the late Pleistocene division in the region extending from the Alps and the Pyrenees as far north as Yorkshire. Nor am I able to form an opinion about their relation to the submergence of Middle or Northern Britain under the waves of the glacial sea. They are quite as likely to be pre- as post- glacial.

The Relation of the River-drift Hunter of the late Pleistocene to the Glacial Submergence.—The rudely chipped implements of the River-drift hunter lie scattered through the late Pleistocene river deposits in Southern and Eastern England in enormous abundance, and as a rule in association with the remains of animals of arctic and of warm habit, as well as some or other of the extinct species of reindeer and hippopotamus, along with mammoth and woolly rhinoceros. What is their relation to the submergence of the land and the lowness of the temperature, which combined together have resulted in the local phenomena known as glacial and interglacial?

The geographical change in Northern Europe at the close of the Forest-bed age was very great. The forest of the North Sea sank beneath the waves, and Britain was depressed to a depth of no less than 2,300 feet in the Welsh mountains, and was reduced to an archipelago of islands, composed of what are now the higher lands. The area of the English Channel also was depressed, and the "silver streak" was somewhat wider than it is now, as is proved by the raised beach at Brighton, at Bracklesham, and elsewhere, which marks the sea line of the largest island of the archipelago, the southern island, as it may be termed, the northern shores of which extended along a line passing from Bristol to London. The northern shore of the Continent at this time extended eastwards from Abbeville north of the Erzgebirge, through Saxony and Poland, into the middle of Russia, Scandinavia being an island from which the glaciers descended into the sea.

This geographical change was accompanied by a corresponding change in climate. Glaciers descended from the higher mountains to the sea level, and icebergs, melting as they passed southwards, deposited their burdens of clay, sand, and erratics, which occupy such a wide area in the portions then submerged of Britain and the Continent.

This depression was followed by a re-elevation, by which the British Isles, again formed a part of the Continent, and all the large tract of country within the 100-fathom line again became the feeding-grounds of the late Pleistocene Mammalia.

An appeal to the animals associated with the River-drift implements will not help us to fix the exact relation of man to these changes, because they were in Britain before as well as after the submergence, and were living throughout in those parts of Europe which were not submerged. It can only be done in areas where the submergence is clearly defined. At Salisbury, for instance, the River-drift hunter may have lived either before, during, or after the southern counties became an island. When, however, he hunted the woolly and leptorhine rhinoceros, the mammoth, and the horse in the neighbourhood of Brighton, he looked down upon a broad expanse of sea, in the spring flecked with small icebergs, such as those which dropped their burdens in Bracklesham Bay. At Abbeville, too, he hunted the mammoth, reindeer, and horse down to the mouth of the Somme on the shore of the glacial sea.

The evidence is equally clear that the River-drift hunter followed the chase in Britain after it had emerged from beneath the waters of the glacial sea, from the fact that the river deposits in which his implements occur either rest upon the glacial clays, or are composed of fragments derived from them, as in the oft-quoted cases of Hoxne and Bedford. Further, it is very probable that he may have wandered close up to the edges of the glaciers then covering the higher hills of Wales and the Pennine chain.

The severity of the climate in winter at this time in Britain is proved, not merely by the presence of the arctic animals, but by the numerous ice-borne blocks in the river gravels dropped in the spring after the break-up of the frosts.

The Range of the River-drift Man on the Continent and in the Mediterranean Area.—The River-drift man is proved, by the implements which he left behind, to have wandered over the whole of France, and to have hunted the same animals in the valleys of the Loire and the Garonne as in the valley of the Thames. In the Iberian peninsula he was a contemporary of the African elephant, the mammoth, and the straight-tusked elephant, and he occupied the neighbourhood both of Madrid and Lisbon. He also ranged over Italy, leaving traces of his presence in the Abruzzo, and in Greece he was a contemporary of the extinct pigmy hippopotamus (*H. Pentlandi*). South of the Mediterranean his implements have been met with in Oran, and near Kolea in Algeria, and in Egypt in several localities. At Luxor they have been discovered by General Pitt-Rivers in the breccia, out of which are hewn the tombs of the kings. In Palestine they have been obtained by the Abbé Richard between Mount Tabor and the sea of Tiberias, and by Mr. Stopes between Jerusalem and Bethlehem. Throughout this wide area the implements, for the most part of flint or of quartzite, are of the same rude types, and there is no difference to be noted between the *haches* found in the caves of Cresswell in Derbyshire, and those of Thebes, or between those of the valley of the Somme and those of Palestine. Nor is our survey yet ended.

The River-drift Man in India.—The researches of Foote, King, Medlicott, Hacket, and Ball, establish the fact that the River-drift hunter ranged over the Indian peninsula from Madras as far north as the valley of the Nerbudda. Here we find him forming part of a fauna in which there are species now living in India, such as the Indian rhinoceros and the arnee, and extinct types of oxen and elephants. There were two extinct hippopotami in the rivers, and living gavials, turtles, and tortoises. It is plain, therefore, that at this time the fauna of India stood in the same relation to the present fauna as the European fauna of the late Pleistocene does to that now living in Europe. In both there was a similar association of extinct and living forms, from both the genus *Hippopotamus* has disappeared in the lapse of time, and in both man forms the central figure.

The River-drift Hunter in North America.—We are led from the region of tropical India to the banks of the Delaware in New Jersey by the recent discoveries of Dr. C. C. Abbott in the neighbourhood of Trenton. After a study of his collections in the Peabody Museum in Cambridge, Mass., I have had the opportunity of examining all the specimens found up to that time, and of visiting the locality in company with Dr. Abbott and Professors Haynes and Lewis. The implements are of the same type as those of the river gravels of Europe, and occur under exactly the same conditions as those of France and Britain. They are found in a plateau of river gravel forming a terrace overlooking the river, and composed of materials washed down from the old terminal moraine which strikes across the State of New Jersey to the westward. The large blocks of stone and the general character of the gravel point out that during the time of its accumulation there were ice-rafts floating down the Delaware in the spring, as in the Thames, the Seine, and the Somme. According to Professor Lewis it was formed during the time when the glacier of the Deleware was retreating ('late glacial'), or at a later period ('post-glacial'). The physical evidence is clear that it belongs to the same age as deposits with similar remains in Britain. The animal remains also point to the same conclusion. A tusk of mastodon is in Dr. Cooke's collection at Brunswick, New Jersey, obtained from the gravel, and Dr. Abbott records the tooth of a reindeer and the bones of a bison from Trenton. Here, too, living and extinct species are found side by side.

Thus in our survey of the group of animals surrounding man when he first appeared in Europe, India, and North America, we see that in all three regions, so widely removed from each other, the animal life was in the same stage of evolution, and 'the old order' was yielding 'place unto the new.' The River-drift man is proved by his surroundings to belong to the Pleistocene age in all three.

The evidence of Palæolithic man in South Africa seems to me unsatisfactory, because as yet the age of the deposits in which the implements are found has not been decided.

General Conclusions.—It remains now for us to sum up the results of this inquiry, in which we have been led very far afield. The identity of the implements of the River-drift hunter proves that he was in the same rude state of civilisation, if it can be called civilisation, in the Old and New Worlds, when the hands of the geological clock pointed to the same hour. It is not a little strange that his mode of life should have been the same in the forests to the north and south of the Mediterranean, in Palestine, in the tropical forests of India, and on the western shores of the Atlantic. The hunter of the reindeer in the valley of the Delaware was to all intents and purposes the same sort of savage as the hunter of the reindeer on the banks of the Wiley or of the Solent. It does not, however, follow that this identity of implements implies that the same race of men were spread over this vast tract. It points rather to a primeval condition of savagery from which mankind has emerged in the long ages which separate it from our own time.

It may further be inferred, from his wide-spread range, that the River-drift man (assuming that mankind sprang from one centre) must have inhabited the earth for a long time, and that his dispersal took place before the glacial submergence and the lowering of the temperature in Northern Europe, Asia, and America. It is not reasonable to suppose that the Straits of Behring would have offered a free passage, either to the River-drift man from Asia to America, or to American animals from America to Europe, or *vice versâ*, while there was a vast barrier of ice or of sea, or of both, in the high northern latitudes.

I therefore feel inclined to view the River-drift hunter as having invaded Europe in pre-glacial times along with the other living species which then appeared. The evidence, as I have already pointed out, is conclusive that he was also glacial and post-glacial.

In all probability the birthplace of man was in a warm if not a tropical region of Asia, in 'a garden of Eden,' and from this the River-drift man found his way into those regions where his implements occur. In India he was a member of a tropical fauna, and his distribution in Europe and along the shores of the Mediterranean prove him to have belonged either to the temperate or the southern fauna in those regions.

It will naturally be asked, to what race can the River-drift man be referred? The question, in my opinion, cannot be answered in the present stage of the inquiry, because the few fragments of human bones discovered along with the implements are too imperfect to afford any clue. Nor can we measure the interval in terms of years which separates the River-drift man from the present day, either by assuming that the glacial period was due to astronomical causes, and then proceeding to calculate the time necessary for them to produce their result, or by an appeal to the erosion of valleys or the retrocession of waterfalls. The interval must, however, have been very great to allow of the changes in geography and climate, and the distribution of animals which has taken place—the succession of races, and the development of civilisation before history began. Standing before the rock-hewn tombs of the kings at Luxor, we may realise the impossibility of fixing the time when the River-drift hunter lived on the site of ancient Thebes, or of measuring the lapse of time between his days and the splendour of the civilisation of Egypt.

In this inquiry, which is all too long, I fear, for my audience and all too short, I know, for my subject, I have purposely omitted all reference to the successor of the River-drift man in Europe—the Cave man, who was in a higher stage of the hunter civilisation. In the course of my remarks you will have seen that the story told by the rudely chipped implements found at our very doors in this place, forms a part of the wider story of the first appearance of man, and of his distribution on the earth—a story which is to my mind not unfitting as an introduction to the work of the Anthropological Section at this meeting of the British Association.

SECTION E

Geography

Opening Address by Sir Richard Temple, Bart., G.C.S.I., D.C.L., F.R.G.S., President of the Section

The Central Plateau of Asia

THE subject chosen for this address is the Plateau of mid-Asia. This area, which is one of the most wonderful on the surface of the earth, contains nearly 3,000,000 of English square miles, and is equal to three-fourths of Europe. Its limits, its exterior configuration, its central and commanding situation in the Asiatic continent, will be clearly perceived from the large diagram of Asia which is exhibited here. As compared with some of the more favoured regions, it is singularly destitute of natural advantages. Though it has several deep depressions of surface, yet its general elevation is very considerable, and some of its large districts are the most elevated in the globe. It is walled in from the outer world and excluded from the benign influences of the sea by mountain chains Its climate then is very severe on the whole, more distinguished for cold than for heat, but often displaying extremes of temperature high as well as low. It offers, from the character of its contour, extraordinary obstacles to communication by land or water. Though seldom inaccessible to courageous explorers, it is generally hard of access, and in several respects very inhospitable. In the progress of civilisation it is, with reference to its historic past, excessively backward. Its capacities for the production of wealth have been but little developed. Its population is scanty, scattered, and uncultured. Its agriculture comprises only a few areas widely segregated from each other, and many of its largest districts are amazingly desolate.

Nevertheless this plateau has eminent claims on the attention of geographers, for several reasons which may be summarised thus:—

1. A mountain system which dominates the greater part of Asia, and includes stupendous ranges with the loftiest peaks yet discovered in the world.

2. A series of heights and depressions almost like the steps

of a staircase within the mountainous circumvallation of the plateau.

3. The sources and the permanent supply of rivers which, passing from the plateau, flow through densely populated regions, and help to sustain the most numerous families of the human race.

4. A lacustrine system, comprising lakes of which some are saline while others have fresh water, and of which many are situated at great altitudes.

5. The home of conquering races, whence warrior hordes poured during several centuries over nearly all Asia and a large part of Europe.

6. Natural products of value, variety, or interest, and pastoral resources susceptible of indefinite development.

7. An enormous field for scientific research, with many regions which, though not wholly undiscovered, yet need much further discovery.

8. An imperial jurisdiction offering many problems for the consideration of social inquirers.

I shall now offer a brief explanation regarding each of the eight points stated above.

In the first place it will be seen from the diagram that the plateau, in shape somewhat of an irregular rhomboid, is completely enclosed by six grand ranges of mountains, namely, the Himalayas looking south towards India, the Pamir looking west towards Central Asia, the Altai looking north towards Siberia, the Yablonoi looking north-east towards Eastern Siberia, the Yun-ling and the Inshan (inclusive of the Khingan), looking towards China. These several ranges preserve generally a considerable altitude varying from 6000 to 25,000 feet above sea-level, and reaching in the Himalayas to more than 29,000 feet. The tallest of these summits have been accurately measured by the Great Trigonometrical Survey of India. Their altitude is about double that of the highest mountains in Europe, and surpasses any altitude yet observed in any quarter of the globe. But as a great part of these several ranges is as yet unsurveyed by trigonometry, it is possible that still greater heights may be discovered, and that "excelsior" may be the proud answer rendered by the everlasting hills to human investigation.

Regarding these and the other chains yet to be mentioned, it must be borne in mind that there are many cross ranges and transverse lines of mountains. Even the chains, too, often consist of detached groups separated by deep valleys. It is by observing the position of the groups relatively to one another that the tendency of the chain can be discerned.

Such being the outer barriers of our plateau, there are within it two great ranges mainly parallel and running from west to east, namely, the Kuen-lun and the Thian Shan.

While the Himalayas form the southern flank of the great Tibetan upland, the Kuen-lun constitutes the northern. The modicum of knowledge possessed by us regarding the Kuen lun, a most important factor in the geography of our plateau, is largely due to the praiseworthy travels of the Russian Prejevalsky. This range may be said in a certain sense to overlook the Tarim basin ending in Lake Lob, though the mountains are actually distant more than a hundred miles from that lake. It forms the southern boundary of the Tarim basin, which contains some of the few beautiful tracts in our plateau. If there be such a thing as a backbone to these regions, or anything like a dorsal ridge, it consists of the Kuen-lun.

The Thian Shan starts from the Pamir, and runs westward for full 1500 miles, till it joins with some of its spurs the uplands of Mongolia proper, or touches with others the dreary desert of Gobi. As the Kuen-lun forms the southern boundary of the Tarim basin, so the Thian Shan constitutes the northern.

Connected with the north-western part of the Himalayas is another range which some regard as an offshoot, but which others treat separately under the name of Karakuram. Together with the Himalayas it joins the Pamir.

Thus three of the greatest mountain ranges in Asia converge upon the Pamir, or according to some are there interlaced; namely, the Himalayas, the Kuen lun, and the Thian Shan; to which perhaps two others might be added, namely, the Karakuram just mentioned and the Altai. But it may be more accurately said that the outer border of our plateau north of the Pamir is formed by the terminal spurs of the Thian Shan. It is to be remembered also that the Indian Caucasus—which does not concern our plateau directly enough to fall within this address—probably joins the Pamir. In general terms, the convergence of mountain ranges on the Pamir renders it geographically the most important position in Asia. The uninstructed Asiatics have evinced a hazy admiration of its grandeur by calling it "the roof of the world." The comparatively instructed Europeans have revered it as the source of the classic Oxus, and as fraught with political considerations. Unless further discoveries shall alter existing information, we may expect that completely informed geographers will consider that this Pamir is the mother of mountains, that other ranges are to it as the branches are to the root, and that here if anywhere is the true boss of the Asiatic shield.

In the second place the vast surface of our plateau, though almost uninterruptedly environed by its rocky walls, presents an extraordinary series of elevations and depressions. In the heart of the plateau there is the depression known to geographers as the Western Gobi, sometimes called the Tarim basin. Within this there is the Lob Lake or Lob Nor, truly an inland sea into which the waters of several rivers ultimately flow, finding no vent towards the ocean. The total length of the Tarim River with its affluents debouching into Lob Nor, cannot be less than 800 miles. This curious and interesting lake is not more than 2000 feet above sea-level and forms almost the lowest dip in our plateau. It is like the bottom of a vast platter, or the centre in the hollow of a mighty hand. Around this depression there are on all sides uplands of various heights like gradations in the Asiatic terrace terminating in the intermediate ranges, or in the outer circumvallation of mountains already described. On the east side of it there is the tract called Eastern Gobi, partly desert, and Mongolia, averaging 4000 feet above sea-level; on the north the Altai uplands, exceeding 5000 feet. On the west the Pamir rises abruptly, exceeding 13,000 feet; on the south Tibet, with equal abruptness, having an average altitude of 15,000 feet above sea-level, thus being the loftiest expanse in the world; and on the south-east the tract around the Kuku Nor Lake, 10,000 feet.

Further, there is a detached depression known as the Zungarian Strait, extending to the northern confine of our plateau between the Thian Shan and the Altai ranges. This strait, hardly exceeding 2000 feet above sea-level, is as low as, perhaps even lower than, any part of our plateau, and is very near breaking its continuity, which may be considered as being just saved by the comparatively humble altitude above mentioned. The depression is geographically important as forming the only broad pass between our plateau and the world without. It runs from Mongolia, the most important tract within our plateau, to Siberia outside. Great value was, in early times, attached by the Chinese to it, as being the only natural highway on a large scale between Northern and Central Asia.

The existence of this and the other depressions above described has led to interesting speculations among geologists as to their having been in primeval times within our plateau at least one inland sea as large as the Mediterranean of Europe.

Be that as it may, there is no doubt that a process of desiccation has been going on within our plateau during historic ages, whereby the climate is considerably affected, and many signs or evidences show that this process is still in operation.

On most of its sides our plateau is extraordinarily inaccessible, the passes being steep in the extreme, and culminating in ridges 18,000 to 20,000 feet above sea-level. Towards Siberia the Altai passes are easier, and on the north-east between Mongolia and China there are several passes that have witnessed the historic outpourings of the Mongol hordes, and which are ominously remembered by the Chinese as the openings through which their invaders rushed like the great river in flood, or the land-slip from the mountain side, or the avalanche sweeping along the boulders and *débris* to the destruction of the valleys beneath.

The great desert of Eastern Gobi occupies the eastern portion of our plateau. With its accumulating forces of sand and powdered earth it has a tendency to encroach, and is regarded by man with a vague awe. Its present extent is enormous, being not less than half a million of square miles. Nor does it exist alone within our plateau, for between the Tarim basin and the Kuen-lun spurs there is a lesser desert called Takla-makan, with 100,000 sqare miles of area. It may probably be found that these two deserts join or are otherwise connected.

In the third place we have noted that while the prevailing characteristics of our plateau are wildness, ruggedness, or desolation, yet within it are the sources of several great rivers which sustain the most teeming peoples on the face of the earth. The monarch as it were of all these noble waters is the Yang-tse-Kiang. Though its head streams have been but imperfectly explored, yet its true source is known to be in the Kuen-lun Mountains already mentioned. After quitting our plateau and passing out of its prison-house in the mountains through natural gates of the utmost magnificence, it permeates the most thickly-peopled provinces of China—provinces inhabited by about 120 millions of souls. It sustains the life of this enormous population by supplying the necessary moisture and by affording the means of irrigation and of water-traffic. No river has ever in ancient or modern times played so important a part in the increase of the human race as the Yang-tse-Kiang. Its supply of water is immense and unfailing, and this most essential characteristic is caused by its connection with the snow-clad and ice-bound regions of our plateau, within which it has a course of 700 miles before entering China proper. Amidst the same Kuen-lun range, the Hoang-ho rises, from unexplored springs, which the Chinese figure to themselves as "the starry sea." After bursting through several water-sheds, making wondrous bends from its main direction near the base of our plateau, and changing its course more than once to the confusion of comparative geography, it traverses Northern China and confers agricultural prosperity on some 70,000,000 of souls. It also has a course of some 400 miles within our plateau, in consequence of which its water-supply is perennially snow-fed. Again, the Irawady and the Mekhong, the former watering Burma, and the latter watering Cambodia, rise in the offshoots of the Kuen-lun. That region, then, in respect of the parentage of important rivers stands in the first rank. This beneficent circumstance arises from the direction of subsidiary ranges which admit to this part of our plateau some of the moisture-laden breezes from the Pacific Ocean.

Similarly the two Indian rivers, the Brahmapu'ra, and the Indus with its affluent, the Satlej, have their origin at a great distance within our plateau, and their water-supply is indefinitely augmented in consequence. Notwithstanding the vast volume of their waters, these rivers play an economic part which, though great, is much less than that of the main Chinese rivers. The Brahmaputra above its junction with the Megna cannot be said to sustain more than 15,000,000 of people; and the Indus, together with the Satlej, may support 12,000,000. The Ganges and Jamna, issuing from masses of snow on the southern scarp of our plateau, sustain before their junction at Allahabad a population of 30,000,000—quite irrespective of the deltaic population of the lower Ganges for whom moisture is supplied from other sources. Of these Indian rivers the waters, perpetually snow-fed, are largely drawn away for canals of irrigation on a grand scale. Taken all in all, despite defects, the Ganges Canal is the most imposing example of hydraulic engineering that has yet been seen. From the glaciers of the Pamir and the western terminus of the Thian Shan there spring the head-streams of the Oxus, the Jaxartes, and other rivers, ending in the inland sea of Aral. To these, in Persian phrase, the epithet of "gold-scatterer" or "wealth dispenser" is felicitously applied by the natives.

Of the rivers rising in the northern section of our plateau, the Amur has possibilities of which the future may see the development. But the great rivers of Siberia, such as the Obe, the Yenisei, and the Lena, though flowing through rich soils and affording marvellous facilities for several systems of inland navigation to be connected with each other, yet have their long estuaries in the permanently frost-bound lands of the Tundra, and their mouths in the Arctic waters frozen during most months of the year. Therefore they can never, in economic importance, vie with the rivers above mentioned, which flow into the Pacific and Indian Oceans.

In the fourth place, the lacustrine system, though not comparable to that of North America or of Central Africa, and not approaching in beauty or interest that of Southern Europe, is yet very considerable. It is not, however, the only one in Asia, and from it must be excluded the three great Siberian lakes of Issykkul, of Baikal, and of Balkash, which, though connected with our plateau, are beyond its actual limits. Exclusive of these, however, the lakes, great and small, within our plateau, are extraordinarily numerous. Not less than a hundred of them may be counted on the maps of this region. Of these lakes, however, some are insignificant, being little more than saline swamps. Others, again, as the Pangong, though romantically beautiful—reposing at an altitude equal to that of the highest European mountains, and reflecting the perennial snow of surrounding peaks—do not illustrate specially any geographical problem, nor produce any economic result. But some may be selected as having a scientific interest irrespective of beauty or of strangeness.

The Lake Victoria, discovered by Wood in 1838, rests in the heart of the Pamir, already mentioned, at an elevation of 14,000 feet above sea-level. It is frozen over during the greater part of the year, and lies with a glistening and polished surface in the midst of a snow-whitened waste. In that state it powerfully affects the imagination of the spectator who reaches it as the final goal, after a protracted and toilsome ascent from the barren or deserted plains of Ariana. It is the source of the Oxus, and is near the point of contact between the British and the Russian political systems in Asia.

In the sharpest contrast to a highly-placed Pamir lake is the Lake Lob, already mentioned. Shallow water, sedgy morass, dreary sands, parched forests, the monotony of desolation, are reported to be its characteristics. It apparently consists of the dregs of an inland sea that is mostly dried up, and is, as it were, kept alive only by the Tarim river, which has its sources in the everlasting snows of the Pamir. Despite the proximity of saline tracts, the lake has fresh water. Near it is a great desert, of which the soil, though now arid and friable, owing to the gradual desiccation, was once more or less productive, and where a population has probably become extinct or has disappeared by migration.

The Pamir then is a water-parting for two inland seas, one the Aral, beyond our plateau, the other Lob Nor within it—both saved from speedy desiccation only by the influx of rivers from the snow line.

Again in contrast is the Kuku Nor, a sheet of water 10,000 feet above sea-level, in the eastern section of the Kuen-lun mountains, near the source of the Hoang-ho. Its waters, profound and saline, have a dark azure hue, which is compared by the natives to that of the exquisite silks in China. It is in the Tangut region, mentioned by Marco Polo in his Itinerary. In respect to the lakes in this region, and especially the morasses of Tsaidam, there are geological speculations as to another Asiatic Mediterranean (besides that already mentioned), long since dried up, whereof there are a few widely-scattered remnants, among which the Kuku Nor is one.

Lastly, a word of passing notice may be devoted to two among the Tibetan lakes, that of Tengri, near Lhassa, on the shore of which stands a venerated Buddhist convent, and the Bul-tso, from which have been obtained quantities of the best borax.

In the fifth place, the north-eastern part of our plateau was during remote ages, beyond the ken of history, the home of hardy and aggressive Tartars. These Tartar races, dwelling among the uplands in the lee of the mountains, used for many centuries to emerge and harry the fertile Chinese plains lying between the mountains and the Pacific Ocean. It was to ward off these incursions that the Great Wall was constructed, winding like a vast serpent of stone along the ridges of mountains for 2,000 miles from the Pacific coast to the Siberian confines. The cost and labour expended on this amazing work attest the dread with which the Tartar highlanders had inspired the Chinese lowlanders. Some centuries after the building of the Wall, the most warlike among the Tartar tribes, in the council of their national assembly, acclaimed Temujin as their king, in the year 1206 A.D. He took a title which is translated by Europeans as Chinghiz Khan, a title which for two centuries or more was the best known name in the whole world. At the head of his Tartar adherents, he first subdued the other kindred tribes of our plateau. Then he organised and disciplined the whole Tartar manhood into an army of horsemen. This is the most wonderful instance of military mobilisation known to history ancient or modern. Its results too were equally appalling. In medieval times the marches of the Arabs and the Saracens, in modern times the expeditions of Napoleon, have dazzled Asia or Europe. These were hardly, however, equal to the distant conquests of Alexander the Great in ancient times. But even the wars of Alexander were perhaps surpassed by the ravages of Chinghiz Khan and the Tartars of our plateau. The countries of China, India, Afghanistan, Bactria, Persia, the Aral-Caspian basin, Siberia, Asia Minor, Russia, were overrun within a hundred years by Chinghiz Khan, his lieutenants, and his immediate descendants. Thus, through the hordes of our plateau there was established a dominion stretching from Cape Comorin near, the equator, to the Arctic Ocean, and from the Pacific shores to the banks of the Vistula in Poland. The latest historian of the Mongols considers that nothing but the unexpected death of the Tartar sovereign, and the political combinations arising in consequence within this very plateau of ours, prevented the Tartar invasion from spreading even to Western Europe. Though it is often held that these terrific events have been overruled by Providence for the progress of mankind, still at the time they caused what Gibbon truly calls a shipwreck of nations. Notwithstanding this, the Tartars won, in a certain sense, an unparalleled success, which is attributed to the geographical circumstances of our plateau.

The influence of the precipices, the forests, the prairies, the wild sports, in forming the national character is so obvious that it need not be specified. We readily understand how the sturdy mountaineer, the daring hunter, the practised archer becomes the able soldier. In Mongolia, however, the local speciality was this, that the practically boundless extent of the pasturage and the nutritious richness of its quality, induced the people to maintain countless horses, cows, buffaloes, sheep, goats, and camels, neglecting the tillage of the soil, never building houses, but living in tents made of warm felt, accumulating a certain sort of rude wealth, still roving and roaming about at some seasons incessantly from one encampment or one grazing-ground to another, dragging with them their families and their effects by means of the pack animals and the roomy waggons drawn by many oxen yoked abreast. Thus was a truly nomadic existence practised on the largest scale ever known. Mongol armies, better drilled, armed, accoutred, and equipped than any forces then known in the civilised world, would emerge from our plateau into the inhabited plains around, and would observe houses and towns for the first time. It is even alleged that some of them had never seen cultivated crops before.

In this state of existence the temptations to depredation of all sorts were excessive, and the danger from the climate, the savagery of nature, and the wild beasts as always imminent. Consequently the Mongals were obliged to hold themselves together by the cohesion of families, clans and tribes. Thus by the force of circumstances a social organisation was established which proved the foundation of a military discipline suitable to the genius of the people, almost self-acting, and unfailing even in the remotest expeditions. The horses, too, upon which the Mongol warriors mainly depended, naturally fell into the training; being always turned out to graze in herds, they habitually kept together, and the field manœuvre fixed habits which had been already acquired. It used to be remarked that a line of Mongol cavalry was like a rope or a chain perfectly flexible but never parted.

The Mongolian food included little of cereals or vegetables, but consisted mainly of cheese and meat. For stimulating drink there was the fermented mare's milk. The name 'koumis' or 'prepared milk,' apparently much esteemed medically now-a-days, is a Mongolian word. Manifestly, men thus nurtured could live in the saddle day and night, carrying with them their sustenance in the smallest compass, and scarcely halting to eat or drink. Thus the hardihood evinced on protracted marches, which would otherwise be incredible, can be accounted for.

It is probable that this diet while sustaining vivacity produced also a violence of disposition. Certainly, ruthlessness, cruelty, indifference to suffering characterised the Mongols and marred the effect of their grand qualities. Massacres, holocausts, conflagrations marked their warlike operations. Even famines and epidemics have hardly done more for depopulation than the Mongol conquests. A Mongolian chief would say that the keenest enjoymet in life was to stamp upon a beaten enemy, to seize his family, and despoil his encampment.

It is not the purpose of this address to describe the policy of the Mongols or the institutions which they founded in conquered countries. A few salient points only have been indicated in reference to the geography of our plateau. It is here, near what is now known as the upper regions of the Amur, that the Onon, the Orkhon, and the Kerulen, classic streams in Mongol story, take their source. Here is the site of Kara Koron, the emperor's head-quarter encampment. Here the Kurultai assemblies were held to decide the fate of nationalities. Here were the camps, the Urts, and Urdus, rude names at first unpronounceable in the civilised world, but soon to become terribly familiar. Here were the hordes mustered under their banners, each standard having its distinctive colour, the supreme ensign being, however, the yak's tail raised aloft. Hither, also, the corpse of Chinghiz Khan was borne in a cumbrous catafalque, dragged through the deep loam by oxen yoked twenty abreast, while his henchmen chanted a dirge which was a pathetic effusion from the heart of a valiant nation, and was full of poetic images drawn from the Mongolian surroundings.

In the sixth place, though our plateau has possessed, and still possesses, some patches of fine cultivation, such as those in the Upper Tarim basin, near Yarkand and Kashgar, and some near Lhassa in Tibet, still it has comparatively but little of agriculture, of trade, or of industry. Nevertheless it has many natural resources of value and interest, while its pastoral resources have proved astonishing. Its breed of horses, though by no means the finest, has yet been quite the largest ever known. These horses have never displayed the beauty of the Arabian or the size of the Turkoman breed. They are middle-sized, and do not attain the speed of thoroughbreds. But in nimbleness amidst rugged ground, in endurance over lengthened distances, and in preserving their condition with scanty nourishment, they are unrivalled. Their numbers too may well exercise the imagination of modern breeders. For many years the Tartar emperors maintained in the field at least 500,000 cavalry, for which the horses were drawn chiefly from our plateau. This enormous cavalry force was engaged in fighting over an area of many thousand miles in length and breadth, during which operations much desperate resistance was encountered. It was occupied in steep ascents and descents, in traversing deserts, in crossing frozen lakes, in swimming rapid rivers. How vastly numerous then must have been the casualties among these horses, and how immense the breeding studs. The pasturage too was so potent in nutritive qualities that ordinarily there was risk of animals suffering from repletion, and emaciated creatures rapidly gained flesh and strength.

In other respects too the fauna are noteworthy—the sheep and goats, with wool or down of the softest texture—the buffalo herds and the yaks inured to the sharpest cold—the gazelles careering in thousands—the untameable camel of the desert having a speed and agility unknown in other species—the wild asses and the white wolves—the waterfowl at times like clouds darkening the air.

The flora too, though less abundant, has its specialities—the pointed grasses sharp enough to pierce leather, the gigantic rhubarb, the magnificent holly, the branching juniper.

The mineral resources of the Kuen-lun are certainly enormous; nobody yet knows how great they may prove. Indeed our plateau is remarkable for the antimony, the sulphur, the saltpetre, the borax, the gold-washings, the turquoise, and the classic jadestone.

In the seventh place, the field offered by our plateau for scientific research will be apparent from even a cursory consideration of the stage to which our knowledge has reached. From the second of the two diagrams, which shows in deep pink those portions of Asia that have been professionally surveyed, in light pink those that have been roughly surveyed, in lighter pink those that have been explored only, and in white those that are unexplored—it will be seen that almost the whole of our plateau is unsurveyed, and that while much of it has been explored more or less, some portions yet await exploration. For some time, however, it has been the sphere chosen by many among the most skilful, enduring, and intrepid travellers of Europe. The journeys of the Russian Prejevalsky in the Tarim basin and Mongolia, of Potanin and Rafailoff in the same region, of Malussovski near Kobdo, of the French missionaries Gabet and Huc in Mongolia, of the Bishop Desgodius in Tibet, of the German Schlagintweit in Turkestan, of the Englishmen Forsyth, Trotter, Johnson, Shaw, Hayward in the Tarim basin, of Wood in the Paymir, of Ney Elias in Mongolia, of Delmar Morgan in Kulja, of Bogle and Manning in Tibet, while teaching us very much, have yet left our minds dazzled with a sense of what remains to be learnt. Even the trigonometrical determination of the Himalayan summits by the English Surveyors General, namely, Everest, Waugh, and Walker, the researches of Basevi, Stolicksa, Godwin-Austen, Thomson, Biddulph, in the same quarter, and the Siberian surveys by the Russians among the Altai and Tian Shan mountains, have brought us only to the verge of half-discovered or undiscovered countries. The greatest unexplored region in all Asia, namely the Kuen-lun range, lies in the very heart of our plateau. It is remarkable too that if the principal geographical problems awaiting solution in Asia be specified, such as the true and ultimate sources of the Hoang-ho, the Irawady, the Salwin, the Mekhong, the relation of the San-po with the Brahmaputra, the connecting links between the Kuen-lun and the Chinese mountain chains, they will be found to concern our plateau.

At a few points only has our plateau been penetrated by geological surveys, namely, in some parts of the Altai and at the western end of the Thian Shan; and these surveys are Russian. But the formations, the strata, the upheavals, the denudations, the fluvial action, awaiting scientific examination, are indescribably great. A notion of some of the questions inviting inquiry from the geologist and palæontologist may be gathered from what has been already said under previous headings in respect to the general desiccation and the subsidence or evaporation of the primeval waters.

To the naturalist few regions present more surprising opportunities for the observation of the coming, the resting, the departing of migratory birds.

To meteorologists many of the natural phenomena must prove highly interesting—the causation of the wondrous dryness, the effects produced on animal comfort by the rarefaction of the air, the mummified bodies dried up without undergoing putrefaction, the clouds of salt particles driven along by furious gusts and filling the atmosphere, the fires in the parched vegetation of the desert, the spontaneous ignition of coal beds, the caves emitting sulphurous gases, the rocky girdle of syenite bounding the Gobi desert, the gradual contraction of the glaciers, the ordinarily rainless zones sometimes invaded by rain-storms with a downpour like that of the tropics.

In the eighth place, our plateau is now under one imperial jurisdiction, and offers many problems for social inquirers. It belongs entirely to the Chinese empire with the exception of one small tract where the Russian authorities have crossed the mountain border. The geographical features for the most part favour national defence and territorial consolidation. The old Chinese Wall is still suitable to the political geography of to-day. In the Zungarian strait, however, in the Ili valley near Kulja, perhaps, also, in the line of the Black Irtish, near Zaisan, the Chinese empire, in its contact with Russia, has weak points strategically, or chinks in its armour. Though the plateau was originally under the Chinese suzerainty, it became, under the Mongolian emperor Chinghiz Khan and his successors, the mistress of China, as indeed of all Asia and of Eastern Europe. As the Mongol power, however, shrunk and withered, the Chinese reasserted themselves. At length under a dynasty, from Manchuria, outside the mountain border, the Chinese became lords over our plateau. The Zungarian tribe of Eleuths rose, and after severe military operations were suppressed. The Muhammadan inhabitants of the Tarim basin rebelled against the Chinese government, and for a while maintained an independent principality for Islam. It was during this time that the British sovereign sent an envoy to Yarkand to conclude a commercial treaty, in 1873. Subsequently the Chinese broke down this rising independence, and the whole region of the Tarim receives its orders from the emperor at Pekin.

The decline and fall of the Mongol empire, the disruption of that wide-spread dominion, like the breaking up of the ice on its own frozen rivers, are historical themes beyond the scope of this address. But the changes which have gradually come over the national character of the Mongolians are cognate to the studies of geographers. As already seen, the annals of the Mongols reveal one of the many examples of the theory of causation, explaining how geographical surroundings mould or affect the human character. There remain the mountains, the sea of undulating uplands, which are still among the few important regions not essentially modified by human action. The pine forests, though hardly intact, have not been extensively cleared. There is the dread desert—where to the ears of superstitious Mongols the rolls of the mustering drums and the shouts of victorious battle are audible—and which has engulfed in sandy waves additional tracts once productive. The pastoral resources, the nomadic diet and exercises, the tribal organisation, are in kind the same as of yore, though perhaps modified in extent or degree. The short-lived heat may perhaps be gaining strength as the ages advance; but the winters must be nearly as long and hard as ever. Thus the same physical and climatic conditions which once caused the Mongolian nation to become one of the mightiest engines ever directed by man are still surrounding the politically degenerate Mongols of to-day, who are best represented by the tribe of Khalkas. Once audaciously ambitious, the Mongols are now sluggish and narrow-minded; once passionately fond of an independence as free as their mountain air, they are now submissive to the domination of races formerly despised by them as inferior; once proud of a tribal organization and a voluntary discipline that wrought world-renowned wonders, they are now split up into factions like a faggot of sticks that has been unbound. A man who, though the feeblest of pedestrians, grips with his bowed legs the saddle of the most restive horse as with a vice, is all that remains of the historic Mongol. It is for the social inquirer to determine what have been the circumstances counteracting the climate and local causes which made this nation potential in moulding medieval history.

Here too may be observed the tendencies of Paganism, Buddhism, and Muhammadism respectively. Of all regions our plateau offers the best means of studying Buddhism, which still counts more adherents than any other faith. Though the mid-Ganges Valley was the birthplace of this widespread religion, and was for ages regarded by pious Buddhists as their holy land—yet during recent centuries the active centre of the faith has been in Tibet. Of the four incarnations of Buddha now held to exist, three are within our plateau, namely, two in Tibet near Lhassa and at Teshu Lumbo, and one in Mongolia at Urga, near the spot where mounds attest the burial of heaps of slain after one of Chinghiz Khan's earliest battles. In Tibet may be seen to the best advantage those religious ceremonies, the sight of which has always attracted the observation of Roman Catholic missionaries.

In conclusion, this brief summary of our geographical knowledge regarding the plateau of mid-Asia is provisional only. For it avowedly deals with regions mostly unsurveyed and seldom even explored completely. Further exploration or discovery therefore may reverse some of our specific conclusions, or may modify the current of our topographical ideas. It is probable indeed that there will be such changes, inasmuch as almost every investigation within this vast area has revealed something unimagined before, or has caused disbelief of something previously believed. This address, then, is limited to a *résumé* of things imperfectly known, with a view of bringing into strong relief two matters which are unquestionable, namely, the importance of our plateau and the grand field it offers for research. If the public consideration of these matters shall induce inquirers to direct their enterprise towards this grand region, we may hope that by degrees the errors in our facts may be removed, the misdirection of our conclusions remedied, the vagueness of our notions made definite. At present the physical obstacles in the path of such enquiries are so grave as to be almost deterring. But they do not finally deter those who after forethought decide to brave peril, distress, sickness, suffering, in order to enlarge the bounds of knowledge. Each inquirer, however, has the consolation of reflecting that he makes the rough ways smoother for those who shall come after him. Every journey that is accomplished must facilitate successive discovery in the same line of country. Probably as fast as one line is made good geographically fresh lines may present themselves, and new vistas will be opened to the astonished gaze of geographers. At length, with all the constancy and courage which arduous travel never fails to inspire, the inquirers of the future will doubtless explore this plateau till it becomes as well known as the Alpine regions of Europe.

SECTION G

MECHANICAL SCIENCE

Opening Address by John Fowler, C.E., F.G.S
President of the Section

Of all the important sections of the British Association the one over which I have now the honour of presiding is, you will all, I think, admit, at once the most practical and the most characteristic of the age. In future times the present age will be remembered chiefly for the vast strides which have been made in the advancement of Mechanical Science. Other days have produced as great mathematicians, chemists, physicists, warriors, and poets, but no other age has made such demands upon the professors of mechanical science, or has given birth to so many men of eminence in that department of knowledge. Though a member of the profession myself, I may venture before my present audience to claim that the civil engineer is essentially a product and a type of the latest development of the present century. Telford has admirably defined the profession of a civil engineer as "being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns." This definition, written more than half a century ago, is wide enough to include all branches of engineering of the present day, although amongst those specifically mentioned the departments presided over by the railway engineer, the locomotive superintendent. and the electrician will be looked for in vain. As Telford was beyond all question the most widely experienced and far-seeing engineer of his time, this little omission well illustrates and justifies my statement that the typical civil engineer of the day is a late product of the present century; for even Telford never foresaw the vast changes which railways, steam, and electricity would evolve in the course of a few years.

My predecessors in this chair have on several occasions stated their conviction that it was better for the author of an address to confine his attention to the particular department of engineering in which he had special knowledge, than to wander over the whole field of mechanical science. A well-informed man has been defined to be a man who knows a little about *everything* and all about *something*. If you give me credit of being a well-informed engineer, I will endeavour to justify your good opinion by showing, whilst presiding at these meetings, that I know a little about steam-navigation, and machinery generally; a little about iron and steel, and other manufactures, and I trust a good deal about the construction of railways, canals, docks, harbours, and other works of that class.

There have undoubtedly been published during the last fifty years many works of mark and merit, but the work which above all others would, I think, have astonished and perplexed our ancestors, is the little one known to all the civilised world as "Bradshaw." This indispensable handbook of the nineteenth century testifies that the face of the country is dotted over literally with thousands of railway stations; that between many of these stations trains run at two-minute intervals, whilst the distance between others is traversed at a mean speed of nearly 60 miles an hour. The public are often justly indignant at the want of punctuality on some railways, but they should blame the management, and not the engineers, for the daily conduct of the heavy traffic between England and Scotland shows, that notwithstanding the constantly varying condition of wind and weather in this climate, a run of four hundred miles can, on a properly laid out railway, and with suitably designed rolling-stock, be accomplished with certainty to the minute, if the management is not at fault. On the Great Northern Railway, for instance, of which I am consulting engineer, the 400 miles between London and Edinburgh is traversed in nine hours, or deducting the half-hour allowed at York for dining, at the mean rate of no less than 47 miles per hour including stoppages. A few months ago the Duke of Edinburgh was taken on the same line of railway from Leeds to London, a distance of 186¾ miles, in exactly three hours, or at a mean rate, including a stop at Grantham, of over 62 miles an hour. I know of no railway in the world where this performance has been eclipsed, and it will be perhaps both instructive and amusing to contrast with it the performance of the engines at the opening ceremony of the Liverpool and Manchester Railway, on September 15, 1830. A newspaper correspondent of the time, after describing many eventful incidents of his journey, proceeds as follows: "The twenty-four vehicles left behind were now formed into one continuous line, with the three remaining engines at their head, and at twenty minutes past five o'clock we set out on our return to Liverpool. The engines not having the power, however, to drag along the double load that had devolved upon them at a faster rate than from five to ten miles an hour (once or twice only, and that but for a few minutes, did it reach the rate of twelve miles an hour), it was past eight o'clock before we reached Parkside. Proceeding onwards, we were met on the Kenyon Embankment by two of the missing engines, which were immediately attached to the three which had drawn us from Maachester. We went still slower than before, stopping continually to take in water (query to take breath), and creeping along at a snail's pace till we reached Sutton inclined plane, to get up which the greater part of the company were under the necessity of alighting and making use of their own legs. On reaching the top of the plane we once more took our seats, and at ten o'clock we found ourselves again at the company's station in Crown Street, having accomplished the distance of 33 miles in four hours and forty minutes."

The incident of the passengers descending from a train headed by five engines to walk up an insignificant incline is, I think worthy of being recalled to the remembrance of the travelling public who are accustomed to see without astonishment a single engine rushing along with a train of a dozen heavy carriages at as high a speed as if it were running alone. We must do our immediate forefathers, however, the justice to remember that even they effected some considerable improvements in the speed of locomotion. For example, in 1763 the only public conveyance for passengers between London and Edinburgh was a single coach, which completed its journey in fourteen days, or at the average rate of 1¼ mile per hour. Strange as it may appear, there are at the present time many large fertile districts in Hungary where, owing to the absence of both road and water communications, a higher rate of speed cannot be attained in a journey of seven day's duration.

An essential condition of the attainment of high speed on the railway, is that the stopping places be few and far between. The Great Northern express previously referred to makes its first halt at Grantham, a distance of 105 miles from London, and consequently but little power and time are lost in accelerating and retarding the speed of the train. In the instance of the Metropolitan Railway, on the other hand, the stations average but half a mile apart, and although the engines are as powerful as those on the Great Northern Railway, whilst the trains are far lighter, the average speed attainable is only some twelve miles an hour. No sooner has a train acquired a reasonable speed than the brakes have to be sharply applied to pull it up again. As a result of experiment and calculation, I have found that 60 per cent. of the whole power exerted by the engine is absorbed by the brakes. In other words, with the consumption of 30 lbs. of coal per train mile, no less than 18 lbs. are expended in grinding away the brake blocks, and only the remaining 12 lbs. in doing the useful work of overcoming frictional and atmospheric resistances.

Comparatively high speed and economy of working might be attained on a railway with stations at half-mile intervals if it were possible to arrange the gradients so that each station should be on the summit of a hill. An ideal railway would have gradients of about 1 in 20 falling each way from the stations with a piece of horizontal connecting them. With such gradients gravity alone would give an accelerating velocity to the departing train at the rate of one mile per hour for every second; that is to say, in half a minute the train would have acquired a velocity of 30 miles an hour, whilst the speed of the approaching train would be correspondingly retarded without the grinding away of brake blocks. Could such an undulating railway be carried out, the consumption of fuel would probably not exceed one-half of that on a dead level railway, whilst the mean speed would be one-half greater. Although the required conditions are seldom attainable in practice, the broad principles should be kept in view by every engineer when laying out a railway with numerous stopping places.

Nearly thirty years ago, when projecting the present system of underground railways in the metropolis, I foresaw the inconveniences which would necessarily result from the use of an ordinary locomotive, emitting gases in an imperfectly ventilated tunnel, and proposed to guard against them by using a special form of locomotive. When before the Parliamentary Committee in 1854, I stated that I should dispense with firing altogether, and obtain the supply of steam necessary for the performance of the single trip between Paddington and the City from a plain cylindrical egg-ended boiler, which was to be charged at each end of the line with water and steam at a high pressure. In an experimental boiler constructed for me, the loss of pressure from radiation proved to be only 30 lbs. per square inch in five hours, so that practically all the power stored up would be available for useful work. I also found by experiment that an ordinary locomotive with the fire "dropped" would run the whole length of my railway with a train of the required weight. Owing to a variety of circumstances, however, this hot-water locomotive was not introduced on the Metropolitan railway, though it has since been successfully used on tramways at New Orleans, Paris, and elsewhere. I am sorry to have to admit that the progress of mechanical science, so far as it affects locomotives for underground railways, has been absolutely *nil* during the past thirty years. The locomotive at present employed is an ordinary locomotive, worked in the ordinary way, except that in the tunnel the steam is condensed, and combustion is aided by the natural draught of the chimney alone, instead of being urged by a forced blast as on open portions of the line. Whether a hot-water, a compressed air, or a compressed gas locomotive could be contrived to meet the exigencies of metropolitan traffic is a question which, I think, might be usefully discussed at the present or some future meeting of the Association.

A reference to the underground railway naturally suggests the wider question of tunnels in general. The construction of tunnels was not one of the novelties presenting itself to railway engineers, for many miles of tunnel had been driven by canal engineers before a single mile of passenger railway had been built in this or any other country. To foreign engineers belongs the honour of having boldly conceived and ably accomplished tunnel works of a magnitude which would have appalled a canal engineer. I need only refer to the Mont Cenis Tunnel, over 7½ miles in length, commenced in 1857 and finished in 1870; the St. Gothard Tunnel, 9¼ miles in length, commenced in 1872 and finished in 1882; and the Hoosac Tunnel, 4¾ miles in length, commenced in 1854 and finished in 1875. In all cases rock of the hardest character had to be pierced, and it is needless to remark that without the aid of the machinist in devising and manufacturing compressed air machinery and rock-boring plant the railway engineer could not have accomplished his task. Intermediate shafts are not attainable in tunnels driven through great mountain ranges, so all the work has to be done at two faces. In the case of the Mont Cenis Tunnel the mean rate of progress was 257 feet and the maximum 400 feet per month. In the St. Gothard Tunnel the mean rate was 429 feet and the maximum 810 feet. In the Hoosac Tunnel the average rate was 150 feet per month.

Tunnels under broad navigable rivers and estuaries have been a subject of discussion by engineers for at least a century, but the only one at present completed is the unfortunate and costly Thames Tunnel. Two important works of the class are, however, now well in hand, the Severn Tunnel at Portskewet, and the Mersey Tunnel at Liverpool. Having reference to this fact, it will be interesting to quote the following passage from a letter addressed to the press by a Mr. Thomas Deakin on March 6, 1835, that is to say, more than forty-seven years ago. Mr. Deakin writes: 'The Great Western Railroad from London to Bristol will be accomplished no doubt, and why not continue it under the Severn mouth, near Chepstow, Monmouthshire, through Glamorganshire, and to Milford Haven in Pembrokeshire? It would then traverse the coal-field of South Wales throughout its whole extent—a tract of country possessing also inexhaustible stores of iron-stone. A tunnel was once so proposed to be formed under the Mersey at Liverpool, and had it not been for the failure of the Thames Tunnel would most probably have been carried into effect." It is not a little singular that the two tunnels thus foreshadowed by Mr. Dakin should both be in hand at the present moment.

Undoubtedly the numerous accidents which occurred during the construction of the Thames Tunnel, together with its enormous cost of about 1,500*l.* per lineal yard, and the eighteen years occupied in its construction, destroyed the chance of any other projected subaqueous tunnel for many subsequent years. One lesson enforced by the Thames Tunnel was the necessity of leaving a reasonable thickness of ground between the water and the tunnel. In the Severn Tunnel the minimum thickness is 40 feet and in the Mersey Tunnel 22 feet. The width of river at the point of crossing of the former tunnel is 2¼ miles, and the maximum depth of rails below high water, 163 feet. In the case of the Mersey Tunnel the width is nearly three-quarters of a mile, and the depth 144 feet. The Thames Tunnel, as almost everyone knows, was carried on by means of a special contrivance termed by Brunel a "shield." No special appliances have been adopted in either of the Severn or the Mersey Tunnels. Both are driven in the ordinary way, but of course enormous pumping power is required and has been provided.

When no special appliances are used in the construction of a subaqueous tunnel, it will be clear to all that an unknown risk is encountered. All may go well, and the engineer will then justly receive congratulations from everyone for his boldness and success. But, on the other hand, something may go wrong, even at the last moment, and I fear the engineer then would be abused no less roundly by the unthinking public for his temerity and consequent failure. It would be a "Majuba Hill" incident over again, and if the accident caused much loss of life the engineer probably would envy the fate of the brave but ill-starred General Colley, who at least fell with the victims of his rashness.

In many cases of tunnels under estuaries, special appliances could be used which would obviate all risk and make the successful completion of the work a mathematical certainty. A tunnel under the Humber, about 1½ mile in length, projected by myself in 1873, the Bill for which was subsequently passed by the Commons and thrown out by the Lords, was a case in point. The bed of the Humber is of very fine silt, and I proposed to build the tunnel in lengths of 160 feet, under the protection of rectangular iron caissons 160 feet long by 42 wide, sunk by the pneumatic process. As the pressure of the air in the caissons would always be slightly in excess of that due to the head of water in the river, no interruption from influx of water could ever occur, and the operation of building the tunnel in lengths inside this huge diving-bell would be as certain and free from risk as the every-day work of sinking a bridge-pier by the pneumatic process.

A tunnel over a mile in length, now in progress under the Hudson River at New York, is being driven through a silty stratum by the aid of compressed air, and with a certain amount of success, as only some twenty men have been drowned up to the present time. The principle upon which the compressed air is used is, however, a false one, since it is merely forced into the tunnel with a view to uphold the ground by its pressure, like so much timbering, and not to keep out the water on the principle of a diving-bell. It is clear, therefore, that the completion of the Hudson River Tunnel, if the present system be persevered in, is purely a matter of conjecture, and all we can do is to hope for the best. The same remark applies, of course, to the Severn Tunnel and the Mersey Tunnel, although in those cases the character of the ground is such that the contingencies are small in comparison with those encountered in the construction of the Thames Tunnel and the Hudson River Tunnel. Nevertheless, as I have already observed, unless special appliances of the nature of the pneumatic process be used, a subaqueous tunnel, whether it be the Channel Tunnel itself or one but a few yards in length, must necessarily present an unknown risk. The prototype of all these tunnels is the one commenced at Rotherhithe in 1809, which was successfully driven a distance of 900 feet under the Thames, and failed when within a little more than 100 feet of the opposite shore. A tunnel about 1½ mile in length was commenced about ten years ago under the Detroit River in America, but was abandoned in a similar manner. So far good fortune has attended both the Severn and Mersey Tunnels, and there is, I am glad to say, every chance of its continuing.

That the series of mishaps with the Thames Tunnel, and the consequent postponement of all other projects for subaqueous tunnels, were due to errors in design and want of foresight on the part of the engineer, is patent to everyone now, and was foreseen by at least one acute contemporary of Brunel himself. Only a few months ago, when turning over the leaves of an old periodical, I became aware of a fact that a scheme, identical in all its main features with my Humber Tunnel project, had been suggested for adoption in the case of the Thames Tunnel, in lieu of the plan proposed by Brunel. Writing in December, 1823, or fifty-nine years ago, the author of the project, a working smith of the name of Johnson, says: "I propose to construct the Thames Tunnel without coffer-dams by making it in parts 28 feet in length, each part having the ends temporarily stopped up, and being constructed on the same principle as the diving-bell. The men dig from the inside round the edge as if sinking a well, and throw the earth towards a dredger, the buckets of which work some feet below the bottom of the excavation. Each length will be suspended between two vessels, and be conveyed to the place where it is let down." A description of the mode of connecting the several lengths is given, and I may add that the tunnel blocks had a sloping face to tend to bring the faces of the joints together, a plan since adopted with the huge concrete blocks at Kurrachee and other harbours. There is not a flaw in the design from beginning to end, as modern experience in the sinking of numerous bridge-piers on precisely the same plan has amply demonstrated. It is beyond all doubt that if the design of this working smith had been adopted in lieu of that tendered by Brunel, the Thames Tunnel would have been completed in a couple of years, instead of eighteen years, and at a cost of about 300*l.* per yard instead of 1,500*l.*

If another tunnel be constructed under the Thames, which is far from improbable, as the requirements of below-bridge traffic necessitate some such means of communication, I venture to predict it will be built in accordance with the plan suggested fifty-nine years ago by the working smith, and not on that of Brunel's Thames Tunnel, or of any other tunnel yet carried out.

At the beginning of the present century a committee was appointed to consider the "practicability of making a land communication by tunnel under the River Forth, at or near Queensferry." In a report dated November 14, 1805, it was recommended that a double tunnel should be constructed at an estimated cost of 164,000*l*., or at the rate of 30*l*. per yard, exclusive of shafts and pumping. The surveyors reporting, grounded their belief in its practicability upon the fact that at Barrowstowness, coal-workings had been carried under the same Firth for a mile, and at Whitehaven coal was worked for the same distance under the Irish Sea, in both places less water being met with under the sea than under the land. The report concludes in the following words: "That a more easy and uninterrupted communication betwixt every part of a country increases the intercourse of commerce, arts, and agriculture, all must know. Ferries are still and often a formidable bar in the road. Of these in this country, the one under review at Queensferry is perhaps the most conspicuous. It is, in fact, the connecting point betwixt the north and south of Scotland, and indeed of the realm, and in this point of view the improvement of it must be considered a national object." These words are as true and as applicable to the case in 1882 as they were in 1805. A ferry still is the only means of communication across the Forth of Queensferry, though the traffic has increased a hundredfold. Parliment, by the passing of the Forth Bridge Act during the present session, has given a practical recognition of the truth of the statement in the above-quoted report, that the improvement of the Forth passage is a "national object."

As you will receive a paper on the Forth Bridge from my partner, Mr. Baker, I will not trouble you with details of the proposed structure at the present moment. I may state, however, that after a careful consideration of the difficult problem, in concert with my able colleagues, Mr. T. E. Harrison, the chief engineer of the North-Eastern Railway, and Mr. W. H. Barlow, chief engineer of the Midland Railway, we unanimously advised the directors of the Forth Bridge Company to abandon the project for a suspension bridge, and to construct a steel girder bridge of the unprecedented span of 1,700 feet. The total length of the structure is 1½ mile, and it includes two spans, as aforesaid, of 1,700 feet, and two of 675 feet, over the navigable channels on each side of Inchgarvie. The execution of the work has been intrusted to me, and my intention is that the Forth Bridge shall be not only the biggest, but the strongest and stiffest bridge yet constructed.

Although great navigable rivers offer the most serious impediments to lines of communication lying at right angles to the direction of the stream, and necessitate such formidable undertakings as the Forth Bridge, with a clear headway of 150 feet above high water, and the Severn Tunnel at a depth of 163 feet below the same datum, still it must be remembered that such rivers were the earliest, and are yet the cheapest, highways for inland communication. Antwerp, the third port in the world, ranking only after London and Liverpool, owes its commercial importance undoubtedly to the Scheldt, which affords admirable water-carriage for a distance of 60 miles from the sea coast inland. London, similarly, is an inland port situated about 50 miles up the Thames; hence one-half of the distance between Antwerp and London is made up of fine rivers capable of being navigated by the largest ocean-going steamers. The practical result of the existedce of this splendid line of natural communication is, that iron girders and rails can be conveyed from the heart of Belgium to the metropolis at a far lower price per ton than from any ironworks in this country. Unfortunately, the southern coast of England and the opposite coast of France are indented by no such rivers as the Thames and the Scheldt, or we should never have heard of the horrors of the "middle passage" in "cockleshell" boats, or of the Channel Tunnel.

To realise, however, the important part which rivers play in facilitating inland communication, it is necessary to glance at the other side of the Atlantic. In Canada, for instance, we have the great inland port of Montreal, where transatlantic steamers anchor some 500 miles from the coast. The very term "stream of traffic" suggests a river, and the St. Lawrence well illustrate, it. Into some small forest tributary of the Ottawa the lumbermen slide a log of timber, and many months after will that log with thousands of others, forming together a huge raft, with huts upon it for the accommodation of the care-takers. be found pursuing its slow but ever continuing progress down the St. Lawrence to Quebec, where it will be shipped to this country.

In Egypt for countless ages the "ship of the desert" and the boats of the Nile constituted the only means of communication. Wheeled carriages were practically unknown, although as long ago as 1832, Mehemet Ali bewildered the pilgrims by starting off for Mecca across the desert in a Long-Acre barouche. But the Nile holds an exceptional position amongst the rivers of the world, for not only was it until quite recently practically the sole means of inland communication for the country through which it flows, but it was, and still is, literally the life of Egypt, since without Nile water there would not be a green spot in the whole of that now fertile land. Having filled the office of consulting engineer to the Egyptian Government for seven years, I have had occasion to give particular attention to the Nile, and I may state that in an average year that river conveys no less than 100,000 million tons of water, and 65 million tons of silica, alumina, lime, and other fertilising soils down to the Mediterranean. The Nile begins to rise about the middle of June, at which time the discharge averages about 350 tons of water per second, and attains in September a height of from 19 feet to 28 feet, and a discharge of from 7,000 to 10,000 tons per second.

Napoleon the Great said that every drop of Nile water should be thrown on the land, and he was right so far as Low Nile discharge is concerned. The cultivated land in the provinces of Lower Egypt have an area of 3 million acres, and to irrigate this effectually at least 30 millions of tons of water per day would be required, an amount somewhat exceeding the whole of the Low Nile discharge. At present the irrigation canals are totally inadequate to convey this quantity, and imperfect irrigation and consequent loss of crops is the result. In many instances a couple of men labour for a hundred days in watering by shadoof a single acre of ground, all which amount of labour might be dispensed with if the barrage of the Nile were completed, and a few other works carried out, the whole of which would be paid for handsomely by a water rate of two shillings an acre. You will gather, therefore, that I do not think the resources of Egypt have been fully developed, magnificent as they even now are, having reference to the size of the country.

It is hardly necessary to say that a net-work of canals laid out with a view to irrigating the lands of lower Egypt can also be used at any time in the event of war for the offensive or defensive flooding of the whole or any part of the said lands. Except for the work of man, Lower Egypt for four months in the year would be simply the bed of a river, and for the remaining months a mud bank. Long before the historic period, however, the Nile had been embanked, and canals, such as the Bahr-Jusef, had been formed; the first, to keep the floods off the land, except in desired quantities; and the second, to run off the inundation waters as soon as the fertilising matters in suspension had been deposited on the lands. Should the inhabitants of Egyyt neglect at any time to maintain the works of their ancestors, successive floods would quickly destroy the embankments and wash the light material into the canals. Thus the whole surface of the country would again be levelled, and the land of Egypt would revert to its primitive condition of being a river's bed for one-third of the year, and probably a malarious swamp for the remainder.

It is hardly possible to refer to Egypt without saying a few words about the Suez Canal. Far-seeing people, including the late Khedive, have long been of opinion that another ship canal will be required in Egypt. In 1876 I submitted to His Highness, in accordance with my instructions, detailed plans and estimates for such a canal from Alexandria through Cairo to Suez. The total length of the canal was 240 miles, and with the same width as the existing Suez Canal the estimated quantity of excavation was 160 million cube yards.

An interesting and significant incident in the history of the Suez Canal occurred in May, 1878, when a fleet consisting of ten steamers and sixteen sailing vessels passed through with 8,412 native troops bound from India to Cyprus. During the same year no less than 58,274 soldiers traversed the Canal. Since 1878 events have marched rapidly, for no one then foresaw that the next important movement of British troops canal-ways would be of a nature hostile in appearance, if not in fact, to the inhabitants of Egypt. The announcement that French and not British troops were to hold the canal was received by the public with an expression of surprise and perhaps of slight resentment, because no one can dispute the vital importance of the work to this country. Periodically the question of the Euphrates Valley Railway is revived, and indeed quite recently I have had to reconsider the question professionally, but this route can never rival the existing one by the Isthmus of Suez.

The inauguration of steam navigation to India was much delayed by the vacillation of the authorities respecting the Suez and the Euphrates Valley routes. Happily, however, the Arabs stole the first bag of mails that went by the Euphrates, and so in 1834 a Committee of the House of Commons finally resolved that "steam navigation between Bombay and Suez having in five successive seasons been brought to the test of experiment, and the practicability of that line being established, it be recommended to His Majesty's Government to extend the line of Malta packets to Egypt to complete the communication between England and India." Nothing appears to have been done during the next two years, but in 1837 a new paddle-wheel steamer, the *Atlanta*, of 650 tons, steamed out to Calcutta, round the Cape in ninety-one days, and was put on the Red Sea station. She left Bombay with the mails on October 2nd, 1837, and arrived at Suez on October 16th. The mails were carried across the desert by camels, and down the Nile to Alexandria in four days, where they remained until H.M.S. *Volcano* took them on board on November 7th. At Malta, on November 16th, they were transferred to H.M.S. *Firefly*, and finally were landed in this country on December 4th, having been in all sixty-three days in coming from Bombay to England. At the present time about eighteen days are occupied in carrying the mails from Bombay *viâ* Brindisi to London.

The town of Southampton, where we are now assembled, has always held a distinguished position in connection with the development of improved communication with our Eastern empire. The opening of the first section of the railway from London to Southampton was coincident with the establishment of steam navigation *viâ* Egypt to India, and in the same year the French engineers at Cairo completed their studies for the proposed railway across the desert to the Suez.

A few months later the London public were startled by an advertisement headed "Steam to New York," and 94 passengers were plucky enough to embark at London, on April 4th, 1838, in the *Sirius*, of 700 tons and 320 horse-power, for New York, where they arrived on the 23rd, having performed the voyage in seventeen days from London, and fifteen days from Queenstown. The *Great Western* sailed from Bristol on April 7th, and arrived at New York a few hours after the *Sirius*, and thus was the great problem of steam navigation to America successfully solved by vessels of small size, and capable of maintaining a speed of but eight to nine miles an hour. I need hardly remind you that since the year 1838 the ships conducting the enormous traffic between Europe and America have been of ever-increasing size and speed. Thus the *Britannic*, built in 1874, has an extreme length of 468 feet, a beam of 45 feet 3 inches, a displacement of 8,500 tons, and a speed of 16 knots per hour; whilst the *Servia*, built in 1881, has an extreme length of 530 feet, a beam of 52 feet, a displacement of 13,000 tons, and a speed of 18 knots, and the *City of Rome*, built in the same year, has a length of 600 feet, a beam of 52 feet 3 inches, and a displacement of 13,500 tons. Another Atlantic liner, the *Alaska*, having a length of 500 feet, a beam of 50 feet, and a displacement of 12,000 tons, attained a speed of 18½ knots on the measured mile, and has done the distance between Queenstown and New York in seven days four hours and thirty-two minutes, and the return voyage in six days and twenty-two hours, a mean ocean speed of, say, 17 knots per hour, or more than double that of the first steam vessels trading in America.

The present generation has grown so accustomed to the embodied results of the progress of mechanical science, that it has long ceased to wonder at big ships, or at any other novelty. To realise what has been attained it is necessary to place ourselves as far as possible in the position of our immediate ancestors, and to look at things through their spectacles. With this view, and to give you some scale of comparison to measure the size of the present Atlantic liners by, I quote a short passage from a newspaper of September 19, 1829, where reference is made to a vessel then under construction, of about the size of one of the much abused "cockle-shells" performing the Channel service between Dover and Calais: "The Dutch have been engaged for the last five years in constructing and equipping a steamboat of extraordinary magnitude, in order to facilitate the communication between Holland and Batavia. It has four masts, is about 250 feet long, and has been appropriately christened the *Monster*. In consequence of her great length, she hung when going off the slips, and it was some days before she was fairly launched; a circumstance which gave the wits of Paris occasion to remark that their Dutch neighbours were so determined to excel all other nations in the magnitude of their steamboats, that they had built one so long that it was several days running off the stocks. One of the most remarkable features of this enormous vessel is her extreme narrowness as compared with her length; her greatest breadth of beam being only about 32 feet. The great size of this vessel will bring to the recollection of our readers the *Columbus*, which was built in the river St. Lawrence in 1824, and made the passage to England in safety, but was afterwards broken up on account of her unmanageable bulk. We shall not be surprised to find that a similar fate awaits the *Monster*, and for a similar reason."

The Channel boat, *Albert Victor*, now on the Folkestone station, is of the same length as the *Monster*, namely 250 feet, whilst the beam of the former is but 29 feet, instead of what the critic of 1829 termed the "extreme narrowness" of 32 feet.

The successive attempts at mitigating the discomforts of the Channel passage by the swinging saloon and twin-steamers of Sir Henry Bessemer and Captain Dicey have gradually prepared the way for what I believe will be the next important step of establishing Channel communication by means of large floating stations, or ferry steamers, capable of traversing the narrow sea between England and France in little more than an hour. Ten years ago I applied to Parliament for powers to carry out this project, and obtained the unanimous sanction of a Committee of the House of Commons. The Bill was, however, thrown out in the House of Lords by the casting vote of the chairman.

What was practicable at that time has now become comparatively easy, owing to the introduction of steel into shipbuilding, and the improvements which have been effected in marine engines and mechanical appliances generally.

Whether the over-sea or under-sea mode of crossing the Channel—the ferry or the tunnel—is to be the adopted scheme will soon be determined. It may be that both will be carried out, and then at least all tastes will be met, and all anticipations respecting the resulting increase in traffic, both in goods and passengers, between the two countries will be brought to the test of experience. However this may be, I am very pleased to be able to announce that my friends Mr. Abernethy and Mr. Clarke Hawkshaw will read papers on the subject, the former on the over sea, and the latter on the under-sea plan, and I shall be disappointed if the papers do not lead to an interesting and valuable discussion.

In few departments of the engineer's work has such progress been made as in that of steam navigation. When in 1820 steamships were first used for conveying merchandise as well as passengers, the tonnage of the whole of the steam traders of this country, it is stated, amounted to but 505 tons. At the present time the corresponding figure is 2½ million tons. Did time permit I would say more on the subject, but I fear that in speaking at all upon steamships I have departed somewhat from my avowed intention of keeping within the sphere of engineering, in which I have chiefly worked. My apology must be that a discussion of railways led me to a consideration of tunnels and bridges, and this naturally suggested a reference to the rivers necessitating the construction of the said tunnels and bridges. From river traffic to ocean traffic is but a step, and so I have been insensibly led to touch upon the wonderful results achieved in recent times by naval architects and mechanical engineers.

I will not similarly err in troubling you with any remarks of mine upon the no less wonderful results achieved by electricians. A description of the work done by my friend Dr. Siemens during the past quarter of a century would in itself constitute a concise history of electrical science. Remembering, however, the warning of King Solomon, that "He who praiseth his friend with a loud voice, it shall be counted a curse to him," I will refrain from referring to Dr. Siemens, or to my immediate predecessor in this chair, Sir W. G. Armstrong, and conclude my address at once with a sincere wish that the present session of the British Association may prove not less interesting and productive of benefit to science than any of those which have preceded it.

NOTES

M. JANSSEN delivered with great success a long address as President of the French Association for the Progress of Science, which met at La Rochelle on the same day that the British Association met at Southampton. The address of Dr. Janssen was very well received, and is reported at length in the *Revue Scientifique*. But La Rochelle being quite a small place, of about 20,000 inhabitants, the interest of the session has been in some respects impaired, and has been mostly confined to the several excursions. The finances of the Association are very prosperous, and its income is exclusively spent in the interest of science.

A HALL of Residence for Women Students at University College, London, and at the School of Medicine for Women, is to be opened next October, at No. 1, Byng Place, Gordon Square, W.C., in the neighbourhood of these institutions. Students who would otherwise live in lodgings, or in non-academic boarding houses, will welcome the opportunities thus afforded, whether most importance be attached to the household arrangements, specially adapted to secure their health and comfort, or to the facilities afforded for quiet study, or to that intellectual and social intercourse with each other which constitutes the fellowship so justly valued in the older Universities. The degrees of the University of London are open to women, and the courses of study which prepare for such degrees are in themselves among the best attainable forms of modern training. University College, London, has supported the action of the University by admitting women on the same footing as men to all the classes of its Faculties of Arts and Law and of Science, and to its libraries, thus throwing open to them a full training in these fields of study. The London School of Medicine for Women, near University College, although not connected with it, is the only institution in England that trains women for degrees in medicine and surgery, and is formally recognised by the University of London. Students of painting, etching, and sculpture have long enjoyed the advantages of the Slade School, which is an important part of one Faculty of Arts in University College, and proximity to the British Museum, with its art collections, will also be considered as another great advantage. On all these accounts the neighbourhood of the College has become a focus for women's education. The very necessary condition is imposed that students applying for admission shall be required to satisfy the committee that their object is serious study; and if any student should require private tuition, the principal is empowered by the committee to make the necessary arrangements. Communications should be addressed to the Principal, Miss Green, 6, Henrietta Street, Cavendish Square. Many well-known names appear in the list of those who approve the scheme; among others, the Countess of Airlie, the Dean of Westminster, Sir F. Bramwell, Mrs. Henry Fawcett, Prof. Carey Foster, Dr. Gladstone, Prof. Huxley, Lady Stanley of Alderley, Mr. B. Samuelson, M.P., Dr. Siemens, Mr. W. Spottiswoode, Prof. Williamson, and the Misses Browne.

THE Sanitary Institute of Great Britain holds its autumn Congress at Newcastle-upon-Tyne, from September 26 to 30. The Exhibition of Sanitary Apparatus and Appliances in connection with the Congress will be held in the Tyne Brewery Buildings, Bath Lane, from September 26 to October 21. The president of the Congress is Capt. Douglas Galton, R.E., C.B., F.R.S. The sections of the Congress are: (1) Sanitary Science and Preventive Medicine, President, Dennis Embleton, M.D., F.R.C.P.; (2) Engineering and Architecture, President, Henry Law, M.Inst.C.E.; (3) Chemistry, Meteorology, and Geology, President, Arthur Mitchell, M.D., F.R.S. On Saturday, September 30, a lecture to the working classes will be given by B. W. Richardson, M.D., F.R.S.

THE Eighth Annual Conference of the Cryptogamic Society of Scotland will be held at Kenmore, Perthshire, on September 4, and following days. Fellows who purpose being present are requested to communicate as soon as possible with Dr. F. Buchanan White, Perth. Kenmore may be reached from Aberfeldy, on the Highland Railway, or from Killin Station, on the Callander and Oban Railway. It is situated at the east end of Loch Tay (on which a steamer has now been placed). The immediate neighbourhood has been favourably reported on as presenting a presumably rich fungus flora, while Ben Lawers and other mountains are distant only a few miles, as is the celebrated Fortingal Yew, supposed to be the oldest living tree in Europe.

CAPT. R. G. MORRIS, R.E., and Lieut. Darwin, R.E., selected by the Astronomer Royal to leave England to observe the transit of Venus, sailed from Plymouth on Saturday afternoon in the *Liguria* of the Orient line. Four German expeditions will soon leave Hamburg for America to observe the transit, being destined for different points of view on the Northern and Southern continents. Each party will consist of two proved astronomers, and a student assistant. The points of observation allotted to the Germans are in Connecticut, South Carolina, Costa Rica, and the Straits of Magellan. The observers will remain at their appointed stations several months, and those at Punta Arenas will be attended and assisted by the Imperial gunboat *Albatross*.

IN the month of September two more statues will be inaugurated in France—one at Nolley (near Dijon) to Carnot, and the other at Serres in Ariege, in the honour of Lakanal. We referred to Carnot at the time his statue was proposed; Lakanal was the secretary of the 11th class of the National Institute when it was established by the Government of the Convention. It was Lakanal who wrote the regulations which are now in existence with a few immaterial alterations. He lived a long time an exile in America, and returned to Paris after the revolution of 1830, and was nominated member of the Academy of Morales and Political Science. The new Minister of Public Instruction will be present at the ceremony, and deliver a speech, in which he will explain the tendency of his administration.

THE mirror of the Leverrier telescope, more than 1 metre in diameter, has been silvered anew by a process employed for the first time with great success. A kind of circular wall in gutta-percha and plaster was built, so that a kind of trough was made with the concave mirror forming the bottom. This space was filled up by the silvering solution, and the operation was terminated as usual by the Leon Foucault process. The trouble of turning over the glass, which weighs 600 kilogs., was thus saved. This success is all the more to be appreciated that the silvering must take place every two or three years. The curvature of the mirror not being quite perfect, it will be used mostly for spectrum analysis of the light emanating from planets.

THE work of building a new central school for "Ingénieurs des Arts et Manufactures," was inaugurated at Paris a few days ago in a square called Carré St. Martin, situated in the rear of the Conservatoire des Arts et Métiers. The laying of the first stone will soon take place, and will be celebrated as a public ceremony. This central school and the Conservatoire will form a "group scholaire" of unexampled usefulness for high industrial studies.

WE announced last week the death of the well-known Russian navigator and explorer, Admiral Count Lütke. Feodor Petrowitch Lütke was born at St. Petersburg on September 29, 1797. He served, in 1813, as a volunteer in the fleet appointed to besiege Danzig, then in possession of the French, and was for his bravery made midshipman. In 1817-18 he accompanied Golowin in the latter's voyage round the world; was commissioned in 1821 to explore Kamtschatka, and in 1821-24 made several voyages in the Arctic regions, devoting himself especially to a survey of the coasts of Novaya Zemlya. His narrative of these voyages still forms one of the richest sources of our knowledge of this part of the Polar Sea. In 1823 Lütke was promoted to the rank of Captain-Lieutenant, and in 1826-28, commanded a Russian exploring expedition around the world, in which he was accompanied by a scientific staff. He explored the Russian shores of Asia and America, and discovered several island groups in the Pacific. Promoted in 1829 to the rank of Captain, he was in 1832 made Adjutant to the Emperor Nicholas, and tutor of the Grand Duke Constantine, whose curator he was from 1847 to 1852. Having been promoted to Adjutant-General in 1842, and Vice-Admiral in 1845, Lütke was in 1851-3 Military Governor of Revel and late of Kronstadt. He was made Admiral in 1855. He was in 1845 founder of the Russian Geographical Society, and since 1864 president of the St. Petersburg Academy of Sciences. He was made a Count in 1866. In 1828 Lütke published the narrative of his Arctic expeditions, and in 1834 the account of his voyage round the world.

THE July number of the *Agricultural Students' Gazette* (Royal Agricultural College, Cirencester) contains an article by Prof. E. Kinch on the Soy bean (*Soja hispida*). This bean, of which there are a dozen or more varieties known in the East, is very largely used as an article of food in Japan and China, where it is manufactured not only into soy, now exported in considerable quantities to Europe, but also into bean cheese and other forms of food. The soy bean in its proximate composition approaches more nearly to animal food than any other known vegetable production, being singularly rich in fat and in albuminoids, and it is therefore a valuable adjunct to the food of the almost vegetarian Japanese. Of late years, especially since the Vienna International Exhibition, many efforts have been made to acclimatise this bean in various parts of the European continent, chiefly in Hungary and Germany. France and Italy have also attempted it, and some of the experiments have been fairly successful. We notice that Prof. Kinch is trying to grow some of the varieties in the botanic garden at Cirencester, and though our climate is probably too uncertain and the temperature often too low for most of the varieties to attain perfection, still if any of them could be acclimatised a valuable leguminous cross would be added to our present list. The paper contains detailed analyses of the bean as grown in different countries, of several of the foods made from it, of its straw, which is a useful fodder, and of the ash of the bean and straw.

IN the same number of the *Gazette* is a useful paper by Prof. H. T. Little on "Rotations," and a short article by Miss Ormerod on "Apple Weevil," as well as much purely college news. The journal in its new form deserves success.

THE Report has been issued of the Technological Examination, 1882, of the City and Guilds of London Institute. The new regulations, in accordance with which this examination was conducted, differed in many particulars from those of the previous year, but principally: (1) in the increased number of subjects of examination; (2) in the substitution of two for three grades; (3) in the permission accorded to candidates to be re-examined in the same grade for a certificate of a higher class; (4) in the reversion to the rule which had previously been in force of examining candidates in one subject only. These differences have to be considered in comparing the results of this year's examination with those of the previous or of any other year. At the recent examination in technology, 1972 candidates presented themselves. This number represents, however, a small proportion only of the number of students who have obtained instruction, during the past year, under the direction of the Institute, and in connection with these examinations. From the returns received in November last, it appears that 3467 students were at that time attending technical classes in different subjects, in accordance with the requirements of the programme; and in many cases the attendance was subsequently increased by students entering the classes after the returns had been forwarded to the central office. A satisfactory increase is shown in the results of the recent examination as compared with that of any preceding year. In 1881, 1563 candidates were examined at 115 centres in 28 different subjects, of whom 895 passed; in 1882, 1972 candidates were examined at 147 centres in 37 subjects, of whom 1222 passed. The provincial centres which, this year, sent up the largest number of successful candidates were Bolton with 124, Glasgow with 109, Manchester with 71, Bradford with 62, and Oldham with 50. By reference to the occupations of the candidates, it is found that in places where there has been a large proportion of failures, many of the candidates are not actually engaged in the industry in which they have been examined. In 16 subjects there has been an increase in the number of candidates. In "Mechanical Engineering," in which the largest number of candidates presented themselves, there has been an increase of 52 candidates. In "Cotton Manufacture" the increase is 140; in "Mine-surveying" 44. Of the 1972 candidates who were this year examined, 506 have not been educated in any of the classes in connection with the Institute, the teachers of which receive payment on results. These students have been prepared in various colleges, such as University College, London, the Technical College, Finsbury, the Yorkshire College, Leeds, University College, Nottingham; or they have supplemented the information gained in the factory or workshop by private study. Of the 1466 who have received instruction in the registered classes of the Institute, 845 have succeeded in passing. The percentage of failures this year, as in former years, is less among the outside candidates, on the results of whose examination no claim for payment is made by any teacher. But, on the other hand, it is very satisfactory to note that the percentage of failures in the registered classes of the Institute has fallen from 50·6 in 1881 to 42·3 in 1882, whilst the proportion of candidates taught in these classes has decidedly increased.

THE steamer *A. E. Nordenskjöld*, belonging to M. Sibiriakoff, left Tromsö on the 18th inst. for the Jenisei. The vessel has on board a cargo of English merchandise, two steam launches, and an engine for the Siberian gold works. The vessel will attempt to save some of the cargo lost in the *Oscar Dickson* in Gydaviken, and return next year with a full cargo of tea, which will be brought from China across the Baikal sea to Kureika on the Jenisei.

THE two Swedish gunboats which conveyed the circumpolar observation party to Spitzbergen, have just returned to Tromsö. Capt. Palander states that it was impossible to approach Mossel Bay, he having made two attempts, on account of heavy pack-ice, and that the party had therefore settled on Cape Thordsten as their residence, where observations commenced on the 15th inst. He further reports that all the Norwegian fishermen he met complained of the unfavourable season and the enormous quantity of ice this summer, no vessel having been able to get higher than Amsterdam Island, from where no opening could be seen by telescope in any direction.

ACCORDING to advice from the Geological expedition, which the Swedish Government has despatched to Spitzbergen this summer, the members were in Isefjord on the 6th inst. pursuing their labours.

AT a meeting of the principal Swedish herring merchants convened at Strömstad this month by Herr von Yhlen, Inspector of the Fisheries of Sweden, this gentleman urged the necessity of establishing a Board of Fisheries as existing in Scotland, and the introduction of the "branding" system in use in the Scotch herring trade, to which the excellent state of this industry in Scotland, he stated, was entirely due. Herr v. Yhlen offered to engage Scotch "coopers" to teach their method, a proposition which was accepted by those present, a sum of money being subscribed for the purpose.

THE additions to the Zoological Society's Gardens during the past week include a Campbell's Monkey (*Cercopithecus campbelli*), a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by the Rev. C. Harris; a Wool Brocket (*Cariacus nemorivagus*), a Hairy Armadillo (*Dasypus villosus*) from Brazil, presented by Mr. C. A. Craven; a Cariama (*Cariama cristata*) from Brazil, presented by Capt. Jones, H.M.S. *Garnet;* four Frogs (—— sp. inc.) from Dominica, presented by Mr. E. Scrutton; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; a Weeper Capuchin (*Cebus fatuellus*) from Guiana, two New Zealand Parrakeets (*Cyanorhamphus novæ-zealandiæ*), two Alpine Parrakeets (*Cyanorhamphus alpinus*), two Golden-headed Parrakeets (*Cyanorhamphus auriceps*), two —— Parrakeets (*Cyanorhamphus*, sp. inc.) from New Zealand, two Peruvian Thicknees (*Œdicnemus superciliaris*) from Peru, four Common Kingfishers (*Alcedo ispida*), British, purchased; a Cape Zorilla (*Ictonyx zorilla*) from South Africa, received on approval.

OUR ASTRONOMICAL COLUMN

THE CLUSTER PRÆSEPE.—At the sitting of the Academy of Sciences of Paris on the 14th inst., a paper was presented by M. Wolf, giving a description of this well-known star-cluster, and micrometric measures of the relative positions of its principal components. M. Wolf made use of the same methods and instruments of the Observatory at Paris which he had employed in 1873-75, in his elaborate scrutiny of the Pleiades. His work upon Præsepe comprises three sections: I. the micrometric determination of the relative positions of its principal stars, to the number of 82, with the filar-micrometer used in 1873-75. The positions of the 82 stars are given relatively to ε Cancri, and are reduced to the beginning of the year 1877, for which epoch the place of the reference star is in R.A. 8h. 33m. 23s.·75, N.P.D. 70° 1′ 18″·0; these stars are between the seventh and eleventh magnitudes. II. The micrometric determination of the relative positions of all the stars in the group to the twelfth magnitude comprised in a rectangle of eight minutes of time by ninety minutes of arc, these determinations being made with the micrometer constructed by M. Wolf for the rapid registration of groups of stars, the places being given to a tenth of a minute of arc by reference to the accurate positions of section I.; this second catalogue includes 188 stars. III. A revision by actual comparison with the sky of the chart of positions so formed, and the insertion of stars omitted or lower than the twelfth magnitude; the chart thus completed contains 363 stars.

Unfortunately there are few ancient observations for comparison. The *Mémoirs* of the Academy of Sciences (first series) contain two charts of the cluster, one formed by Cassini and Lahire in 1692, the other by Maraldi in 1707, but they only serve for identification of certain stars, and give neither positions nor exact magnitudes. In 1790 Le Monnier published a catalogue of 31 stars, of which 18 occur within the limits of M. Wolf's chart; 15 of these correspond to his observed positions, with a mean error of ±0·4s. in R.A. and ±13″ in N.P.D. Le Monnier's Nos. 7, 11, and 19 do not correspond within these limits to any existing stars, but there is no reason to infer great displacement, since Lalande assigns positions which nearly agree with M. Wolf's.

Prof. Winnecke observed some years since with the Bonn heliometer the principal stars in this cluster, but his results are not yet published. In 1870 Prof. Asaph Hall published a catalogue of 151 stars observed at Washington in the years 1864–1870, the places being in close accordance with those obtained by M. Wolf.

THE EXPECTED RETURN OF THE COMET OF 1812.—Extensive sweeping ephemerides prepared by MM. Schulhof and Bossert, after a rigorous discussion of the observations in 1812, have been issued by the Observatory at Paris. They find the most probable period 71·7 years, one year longer than was assigned by Encke, who first proved the impossibility of representing the observations by a parabola. Further, they consider the effect of planetary perturbation since 1812 may bring the comet again to perihelion about the middle of the year 1883. But there is an uncertainty in the actual period of revolution in 1812 amounting to ±3¼ years, so that it is desirable to institute at once a systematic search for the comet. The ephemerides in question are for the three months, August—October; with the sun's true longitude as argument (or, more approximately, with the date), twenty-five positions corresponding to different values of the comet's true anomaly are found, which indicate the curve in which it should be sought at the time. The data are too extensive to be reproduced here, and their utility would be diminished by curtailment. It may be presumed that the ephemerides will be within reach of any practised observer who contemplates taking part in the search for the comet. In 1812 the distance from the earth at the time of discovery by Pons was 1·81, and from the sun 1·30, consequently the theoretical intensity of the light was 0·18. According to Bouvard, it became visible to the naked eye on August 18, with a pretty bright nucleus and a tail of 2°. On September 12 we read: "La queue de la comète est divisée en deux branches parallèles; sa longueur paraît d'environ 3 degrés."

SCIENTIFIC SERIALS

Journal of the Franklin Institute, August.—On a theory of Rankine relating to the economy of single action of expansion engines, first published in 1851, by Prof. Trowbridge.—The specific heat of platinum and the use of this metal in the pyrometer, by Mr. Hoadle.—Bell chimes in Philadelphia and other places, by Mr. Nystrom.—Electric clocks and time-telegraphs, by Mr. Spellier.—Feldspar as a source of potash alum, by Mr. Spiller.—On the prevention of fires in theatres, by Mr. Hexamer.—Report of the special committee on the pollution of the Schuylkill River.

Journal of the Russian Chemical and Physical Society, vol. xiv. fascicule 6.—On the specific volumes of elements in liquid and solid compounds, by M. Schalfeyeff. The coefficients of diminution of volume of two elements entering into chemical combination gives, according to the author, a measure of the chemical energy of combination and determines the position of the different elements in the natural scheme of Mendeleeff.—On nitric ethers of the lactose, by Dr. Gué.—On the formation and decomposition of the acetanilide, by Prof. Menshutkin, being a new work undertaken in connection with the researches on etherification.—Barometographe by weight, by M. Kraevitch.—On the influence of dilatation on the electrical resistance of copper and brass wire, by M. Chwolson.—Demonstration of the distribution of electricity on the superficy of conductors, by P. Van-der-Vlieth.—Photo-electric battery, by J. Borgmann.—On the existence of a pondero-electro-kinetic part of energy in the electro-magnetic field, by R. Colly.—Necrology of G. C. Brauer, the able optician of the Pulkova Observatory, to whom this observatory, as well as the Russian General Staff and Russian travellers generally, are so much indebted for so many beautiful instruments and so many remarkable adaptations of scientific instruments for travelling purposes.

CONTENTS

THURSDAY, SEPTEMBER 7, 1882

ANIMAL INTELLIGENCE

Animal Intelligence. By George J. Romanes, M.A., LL.D., F.R.S., Zoological Secretary to the Linnean Society. International Scientific Series. (London: Kegan Paul, Trench, and Co., 1882.)

THE psychology of animals having hitherto been treated only in detached portions, and for the most part in an uncritical manner, Dr. Romanes has "thought it desirable that there should be something resembling a text-book of the facts of comparative psychology, to which men of science, and also metaphysicians, may turn whenever they may have occasion to acquaint themselves with the particular level of intelligence to which this or that species of animals attains." But this is only one of the objects with which he has undertaken the treatment of the psychology of animals. The second and more important object "is that of considering the facts of animal intelligence in their relation to the theory of Descent." The present volume supplies the basis for this mode of considering the facts. "While complete in itself as a statement of the facts of Comparative Psychology," it is preliminary to a second division of the work, which is to be brought out as a separate treatise under the title of "Mental Evolution."

Since the present volume is to be regarded as the first part of a scientific treatise, it is, of course, important that we should know the critical principles on which the facts have been selected. Dr. Romanes has stated these in his preface. It will not be denied that his canons of criticism are sufficiently severe; and in the book itself we do not receive that impression that the facts are being described without careful discrimination, which often makes itself felt in reading collections of anecdotes about animals. But, considering the possibilities of the subject, most readers will look for descriptions which may be scientifically accurate or not, but which, in either case, are interesting in themselves. And, notwithstanding the intention he has expressed, "as far as the nature and circumstances of the inquiry would permit, to suppress anecdote," Dr. Romanes has written a book that is very pleasant to read. Besides this, the materials are arranged in such a way that there is no difficulty in finding any fact that it is desired to refer to.

Dr. Romanes points out more than once "how slightly a psychological classification of animals depends upon zoological affinity, or even morphological organisation" (p. 241). The zoological classification is followed for the sake of its convenience, but at the same time it has, of course, been found necessary to treat some groups in much more detail than others. "Anatomically, an ant or a bee does not require more consideration than a beetle or a fly; but psychologically there is need for as great a difference of treatment as there is in the not very dissimilar case of a monkey and a man" (Preface, x.). As an example of the mode of classifying the facts relating to each group, the chapter on Ants may be referred to. First the researches are described that have been made in order to determine the exact character of the special senses of ants, and of the "sense of direction." After this, the powers of memory and recognition are considered, then the emotions. Then follow sections on the powers of communication, the habits, and the general intelligence of ants. Lastly, there is a short section on the nervous system and the sense organs; but this is not represented in the chapters dealing with other animals.

Though the complete theoretical treatment of mental phenomena in animals does not belong to the present volume, yet there is in the Introduction some discussion of theoretical questions. This was indeed necessary in order to arrive at a provisional mode of grouping the facts. For it has been objected to those who speak of the "emotions" of an ant or a bee, for example, that we are not justified in applying terms derived from human psychology to animals so remote in structure from the human type. Dr. Romanes replies to this objection by showing that the ground of all inferences as to the mental processes of animals is an argument from the analogy of their actions with our own. "Now it is, of course, perfectly true that the less the resemblance the less is the value of any analogy built upon the resemblance, and therefore that the inference of an ant or a bee feeling sympathy or rage is not so valid as the similar inference in the case of a dog or a monkey. Still it *is* an inference, and, so far as it goes, a valid one—being, in fact, the only inference available. That is to say, if we observe an ant or a bee apparently exhibiting sympathy or rage, we must either conclude that some psychological state resembling that of sympathy or rage is present, or else refuse to think about the subject at all; from the observable facts there is no other inference open" (p. 9).

Assuming that we are justified in concluding that the mental processes are similar when there are similar external appearances, we still need a criterion of mental as distinguished from reflex action; for we find both in men and animals examples of actions that are "mind-like and yet not truly mental." "Objectively considered, the only distinction between adaptive movements due to reflex action and adaptive movements due to mental perception, consists in the former depending on inherited mechanisms within the nervous system being so constructed as to effect *particular* adaptive movements in response to *particular* stimulations, while the latter are independent of any such inherited adjustment of special mechanisms to the exigencies of special circumstances" (p. 3). The criterion proposed is therefore—"Does the organism learn to make new adjustments, or to modify old ones, in accordance with the results of its own individual experience?" If it does, we have evidence that the limit of non-mental action has been passed; that is, we are able to fix, by means of this criterion, "the upper limit of non-mental action." After distinguishing reflex from mental action, it remains to distinguish "instinct" from "reason." Dr. Romanes proposes to define instinct as "reflex action into which there is imported the element of consciousness," and "reason or intelligence" as "the faculty which is concerned in the intentional adaptation of means to ends" (p. 17).

Dr. Romanes in his Introduction defends these last definitions against several objections, but the strongest argument that can be brought against them is found in the actual treatment of the phenomena of instinct and "general intelligence" in the chapters that follow. In discussing, for example, the question of the general intelligence of ants, Dr. Romanes speaks of "the difficulty of drawing the line between purposeless instinct and purposive intelligence." He then goes on to say, "It will be remembered that our test of instinctive as distinguished from truly intelligent action is simply whether all individuals of a species perform similar adaptive movements under the stimulus supplied by similar and habitual circumstances, or whether they manifest individual and peculiar adaptive movements to meet the exigencies of novel and peculiar circumstances" (p. 123). Now this distinction between instinct and reason, when it comes to be applied, does not seem to be essentially different from the distinction between mental and reflex action. The distinction of instinct as having an element of consciousness from mere reflex action which is unconscious, seems to vanish in the actual treatment of the subject; and the way of answering the question as to instinct that suggests itself most strongly is to define it with Mr. Spencer as "compound reflex action," placing both instinct and reflex action, as merely mechanical processes, in opposition to all conscious action.

If we take this view, we must regard all animals from the lowest to the highest as having a certain measure of "general intelligence." In the higher animals this general intelligence may be as highly developed as the mechanical processes described by the term instinct. For example, Dr. Romanes says, in speaking of the beaver, "It is really impossible by the closest study of the psychology of this animal to distinguish the web of instinct from the woof of intelligence; the two principles seem here to have been so intimately woven together, that in the result, as expressed by certain particular actions, it cannot be determined how much we are to attribute to mechanical impulse, and how much to reasoned purpose" (p. 367). Now there seems to be an advantage here in confining the term instinct to the mechanical processes and calling all the rest "general intelligence." And Dr. Romanes, except in the Introduction, seems to have looked upon the facts in this way. But in considering the question how the terms should be defined, the difficulty no doubt presented itself that reflex action, instinct, and reason are usually thought of as an ascending series. This, however, is merely because the animals in which reflex, instinctive, and rational action respectively are most prominent, form an ascending series in the scale of intelligence. The difficulty disappears when we regard all animals as having some general intelligence; for we can arrange them in an ascending series (as Dr. Romanes proposes) according to the amount of consciousness possessed by them; contrasting all along the line "non-mental neuro-muscular adjustment" (simple or "reflex," and compound or "instinctive") with the mental life properly so called.

That all animals have some consciousness, some "general intelligence," is regarded as probable by Dr. Romanes; and perhaps the most interesting portions of the book are the early chapters in which he proves the presence of an element of consciousness in animals very low in the zoological scale. "Even the headless oyster," he quotes from an unpublished MS. of Mr. Darwin, "seems to profit by experience." And this power of profiting by experience, it must be remembered, is the test of rational as distinguished from instinctive action. But we find evidence of conscious purpose even below mollusca. Dr. Romanes records an observation made by himself on rotifers, and says that if we were to depend upon appearances alone, this one observation would be sufficient ground for attributing conscious determination to these microscopical organisms (p. 19). Then after quoting "some observations relating to the lowest of all animals and made by a competent person," he remarks that "although we may suppose that the adaptive movements described by Mr. Carter were non-mental, it still remains wonderful that these movements should be exhibited by such apparently unorganised creatures [*amœbæ*], seeing that as to the remoteness of the end attained, no less than the complex refinement of the stimulus to which their adaptive response was due, the movements in question rival the most elaborate of non-mental adjustments elsewhere performed by the most highly organised of nervous systems" (p. 22).

Now these phenomena, if they are ascribed to mind at all, certainly cannot be ascribed to instinct. And it is scarcely possible, consistently with the principles laid down by Dr. Romanes, to deny that they are mental. It therefore seems as if we must admit the presence of the intelligent and volitional element in Protozoa; and this view suggests itself more strongly when we consider the nature of the movements of these animals, and when at the same time we remember Mr. Spencer's description of instinct passing into intelligence by losing its perfectly unhesitating or "automatic" character.

In the higher (as regards morphological organisation) but less plastic animals Cœlenterata and Echinodermata, Dr. Romanes finds nothing that cannot be explained as reflex action. Taking this into account along with the facts already mentioned, we may infer that the opposition between intelligent and mechanical action which shows itself in the tendency of each to encroach on the region possessed at any particular time by the other, is present from the beginning of life; and thus the division of all that is included in mind into free intelligence and organised habit (instinctive or reflex) subordinate to it, is seen to be preferable to the division into reflex action, instinct, and reason.

The kind of opposition that must always exist between these two things when they have become distinct may be made clear by bringing together the general results of the chapter on Instinct in the "Origin of Species," and of those portions of Mr. Spencer's "Principles of Psychology" mentioned by Dr. Romanes in his preface. Mr. Darwin showed, in the chapter referred to, how the most complicated instincts may be formed out of purely reflex actions by natural selection: and Mr. Spencer had already shown in the first edition of the "Psychology" how instinctive processes pass into rational processes when they become too complex to be performed unhesitatingly; and how, on the other hand, rational processes when they are often repeated become habits, and may at length be fixed by heredity as secondary instincts. More recently Mr. Spencer has shown grounds for thinking that natural selection is most important in the early stages of evolution, while the formation of habits which at first are conscious, but at last pass into instincts, is most important in the later stages of evolution. But in any case we see here both the continuity of instinct with reflex action and the constant opposition that there is between mechanical quasi-mental action and free intelligence. On the one hand the organism tends to become excessively specialised by the development of instincts under the influence of natural selection and by the formation of habits; on the other hand rational processes are constantly being applied to slightly different material, thus becoming more varied, and instincts when they become too complex are partially disorganised and contribute their share to the activity of the free intelligence. Thus, starting with a lowly organised animal having the beginnings of intelligence and reflex action, that is, having the germs of the mental and quasi-mental processes of the higher animals, we observe from this point onwards both a process of development of each kind of action along its own line and a process of transformation of each kind of action into the other.

In some ancient civilised societies of men, habits which were originally special applications of reason to particular ends have encroached to such an extent on the free intelligence that almost the whole of life has become mechanical routine. If the specialising tendency can go so far in the case of men, may we not expect to find animals rather high in the zoological scale (perhaps some species of insects) in which *all* the mental activity has passed into the form of instinctive processes? The complementary problem to that of finding evidences of intelligence in the lowest animals would be that of finding evidences of the absence of intelligence in the higher animals. In discussing ants Dr. Romanes remarks that some species do not seem to have general intelligence in proportion to the complexity of their instincts, though "other species . . . appear to be as remarkable in this respect as they are in respect of their instinctive adjustments" (p. 127). But if there is a constant struggle between instinct and intelligence, an animal in which instincts have been fixed so rapidly that all the plastic intelligence has been absorbed in forming them is quite possible, and might be found perhaps among insects. Such an organism would be a realisation of the idea of Descartes that animals are unconscious automata.

T. WHITTAKER

DALTON'S "HUMAN PHYSIOLOGY"

A Treatise on Human Physiology, designed for the Use of Students and Practitioners of Medicine. By John C. Dalton, M.D., Professor of Physiology and Hygiene in the College of Physicians and Surgeons, New York. 7th Edition. (London: J. and A. Churchill, 1882.)

THE seventh edition of this excellent work shows on almost every page that the author has submitted the previous edition to careful revision, with the result of producing a much better book in every respect. Statements are made more concisely and to the point; irrelevant or useless illustrations are suppressed; redundant sentences have been clipped and pruned till they express their meaning in the shortest form. Further, the arrangement of the book has been much improved. In the 6th edition, Dr. Dalton discussed the subject under the heads of "Nutrition," "The Nervous System," and "Reproduction," whilst in the present edition he has subdivided the first section into "Physiological Chemistry" and "Nutrition," properly so called. This arrangement has enabled him to describe more fully the chemical composition of proximate principles and to arrange the facts in a more natural order. As a matter of logical arrangement, it is doubtful how far Dr. Dalton is justified in treating of the Bile under "Digestion," and the Glycogenic Function of the Liver under "Absorption," but no doubt he has felt the difficulty experienced by those who have been obliged to deliver a systematic course of lectures on physiology as to the natural position of those important functions. At what point do they come in, if it be the object of the teacher to describe facts in natural sequence and in such a way as to help the student in grasping an idea of the entire mechanism? In the digestive process, the bile plays a comparatively unimportant part whilst the production of glycogen by the liver has little to do with absorption. Still both of these processes have a natural relation to the great functions under which Dr. Dalton has placed them, and an author may be excused for arranging them as he has done, on the ground that it is impossible for any one, with our present views of nutrition, to state precisely under what head, in any systematic treatise, these functions should be described.

In discussing the "Nervous System," Dr. Dalton has judiciously incorporated the facts brought to light by recent investigators. Thus we have a careful description of the physiological anatomy of the cerebral hemispheres and associated ganglia, and an account of the experimental evidence supplied by Fritsch and Hitzig, Ferrier, Schiff, Hermann, and Carville and Duret. In particular, prominence is given to the attempts of Ferrier and others to determine special centres for sensory perceptions, and to what may be called the "check" experiments of the New York Society of Neurology and Electrotology. Less importance is justly given to the results reached by the rough method of extirpation followed by Flourens and many others. Not a few still doubt the view that there are portions of the cerebral convolutions devoted to special motor or sensory functions, but the student will find in Dr. Dalton's pages a very clear exposition of the results of modern investigation.

The chapter on the "Senses" is clear and intelligible so far as it goes. It does not pretend to give an account of the almost innumerable phenomena of the senses, but it gives a fair representation of the more common phenomena, whilst it is suggestive and critical. The account of the mechanism of accommodation is meagre and might be much improved. No account is given of any theory of colour-perception. The account of the auditory mechanism is excellent, and the author is extremely careful in discussing the attempts made to explain the organ of Corti.

The special feature of this book, in all editions, is the prominence given to the function of *reproduction*, and we may add that no text-book of a general character gives so full and explicit an account of this department. Here, as elsewhere, the author has endeavoured to be a teacher, and has aimed not so much at giving a detailed account of all the steps of the process as at presenting the subject in a form easy of comprehension. Thus whilst it might be possible to point out statements slightly erroneous or deficient in fulness, no one can refuse a compliment to the skill with which the learner is led on step by step through the intricacies of reproduction and development.

The popularity of the work is likely to give Dr. Dalton the opportunity of preparing another edition, and we would suggest, in particular, that further details be given as to the physiology of muscle. A student who has a fair knowledge of the structure of muscular fibre, its chemical composition at rest and in action, its relations to the nervous system, and, in short, the history of its life, has a good grounding in the fundamental principles of physiology. Again, the accounts of the ultimate changes in the respiratory process, of the functions of the kidney, and of secretion are meagre, and give an amount of knowledge not likely to satisfy the requirements of various examining boards in this country. The histology of the tissues and organs might also, with advantage, be given more fully.

When a teacher writes a text-book it may be taken as an indication of his method of teaching the subject, but often the order in which subjects are discussed is changed from a desire to give a logical and systematic exposition. To deluge a beginner with a sea of facts relating to the chemical composition of the body is likely to confuse him and to make the subject distasteful, but whilst this is a caution to the teacher, it is quite justifiable for an expositor in print to begin with such wearisome details. With Dr. Dalton's method little fault can be found. He leads a beginner, by easy stages, through many difficult problems, whilst it is clear he has thought out the matter for himself and thus can clearly indicate how much may be taken as fact and how much may be accepted as theory.

Whilst Dalton's "Physiology" is not on a level with that of Dr. Michael Foster in being a representation of the most advanced opinions in physiological science, nor with Hermann's "Physiology" (translated by Prof. Gamgee), Beaunis' "Physiologie," Landois' "Lehrbuch der Physiologie des Menschen," or Carpenter's "Human Physiology," as a repertory of facts, it is a compendium well suited, on the whole, for a student of medicine. As a rule, successive editions of a popular work become larger, but in the present instance the author has been able to sift and refine so as to save space, without injuring the quality of his work. JOHN G. MCKENDRICK

OUR BOOK SHELF

Synthèse des Minéraux et des Roches. Par F. Fouqué et M. Lévy. (Paris: G. Masson.)

THE authors of this work have earned for themselves so high a reputation by their numerous and successful experiments in the synthesis of minerals and of rocks, that we may almost take for granted the thoroughness of the work now issued. Till the appearance of this volume the results obtained since 1872 (when a similar compilation was published by Fuchs) were to be sought in scattered memoirs; all results up to the present date are here collected into a single treatise, provided with an excellent set of indices. In an interesting but brief introduction (thirty pages) the advantages accruing to mineralogy and petrology from these syntheses are pointed out and the various methods of experiment explained. The next fifty pages are devoted to the experiments having for aim the synthesis of rocks, and the remainder of the volume (300 pages) to those which have resulted in the reproduction of minerals. In each instance careful references to the original memoirs and a distinct statement of the application of the results to geology are given. The book is very well printed on good paper, and has for frontispiece a coloured plate showing the appearance in polarised light of thin sections of artificial leucotephrite and basalt.

L. F.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Australian Aborigines

I OBSERVED in NATURE, vol. xxiii. p. 584, a critique from the pen of Mr. D. McLennan upon "Kamilaroi and Kurnai," the joint work of Mr. Fison and myself. On perusing it I wrote a reply to statements it contained, but owing to various causes I laid it for a time aside. Indeed I did not feel in any hurry to reply to criticisms which really did not touch my arguments. As, however, I observe that attacks are still being made elsewhere upon the conclusions at which Mr. Fison and I have arrived, and that substantially the same arguments are still being made use of which were used by Mr. McLennan, it has seemed to me that the time has arrived to meet these objections at any rate in a general manner. It is not possible in the space which I may hope that you will give me in your valuable pages, to enter upon details which would be absolutely necessary to render clear to my critics certain points which they have evidently misunderstood, perhaps from want of clearness on my part, possibly also from want of knowledge by themselves of the subject as it exists in the Australian field. I therefore now confine myself to some prominent points.

It is absolutely necessary, in order to perceive the structure of an Australian tribe with clearness, to distinguish between *clan* as a part of its local organisation, and *class* as a part of its social organisation. By this I do not mean "clan" in its ordinary acceptation, as, for instance, the "clan of the McPhersons," but a division of the local organisation which stands in relation to a division of the social organisation as *mutatis mutandis* did the Dime to the Phratria of Attica. These two organisations exist in all tribes with which I am acquainted, but in no two tribes in the same relative proportion. For the local organisation of the Kurnai tribe I have already used the word *clan*; for its social organisation I should use the word *class*. But the only two class-divisions of the Kurnai are the bird totems Yeerung and Djeetgun, which, as my critics take pleasure in pointing out, "divide the tribe into men and women." That there are, however, real totems in an abnormal form, is shown by their cinalogues occurring together with totem classes of the ordinary type in tribes of South Eastern Australia over an area extending more than 600 miles east and west. Some of these tribes have uterine, and others have agnatic descent.

In exogamous tribes having uterine descent there are no totem-clans; in tribes having agnatic descent there may be totem-clans where the *class* and the *clan* have become coterminous. The persistent use of this word "totem-clan," without regard to its application, shows in our critics a want of acquaintance with the nature of the Australian evidence.

It is not possible to argue correctly from the customs of one tribe to that of all Australian tribes, as our critics appear to do, for the customs of the tribes are very diverse. Tribes adjoining each other may be found to have each a distinctly different social organisation. It is a most misleading practice to criticise by arguing from the reported customs of one tribe to the customs of distant or of all Australian tribes. The further my inquiries extend, the clearer this comes out. The case of half-sister marriage among the Kamilaroi is an example. My inquiries have not as yet brought to light any other Kamilaroi tribe practising it than that one reported on by Mr. Lance. Yet my inquiries show that the Kamilaroi organisation in classes, sub-classes, and totem-classes extends far beyond the true Kamilaroi country northwards into Queensland, over an extent of country more than eight hundred miles north and south. The classes, sub-classes, and totem classes can be even identified with each other in dialectic forms. Not only do these totem-classes regulate marriage and descent, but the sub-classes, *i.e.* their well-known form as Ipai-Kumbo and Muri-Kubi, do so likewise, and moreover the two primary classes which I have now succeeded in tracing out over the area named are those in fact in considering the legality of marriages the aborigines finally look. It is, in fact, these two primary classes which, through their four subdivisions and the group of totem names, imperatively regulate marriage. They are the two exogamous intermarrying groups into which the tribe in its social organisation is divided. The marriage of two individuals belonging to one primary class is regarded in the light of incest, and is very generally punished by death. Thus the objections which have been taken that the class-names do not influence marriage and are mere terms of address receive renewed and positive contradiction from accumulating evidence.

As to the objections taken to my statement of the practice of marriage by elopement among the Kurnai, I have little to add to the full account I have given in my work in that tribe. Mere denials of its existence, mere statements that marriage by elopement is a "product of misconception," do not alter the fact that the practice existed in Gippsland, as I have stated it. The difficulty which has been raised as to the elder men obtaining wives and second wives amounts to nothing. It may interest my critics to know as one instance that the man King Charley, whom I mentioned in "Kamilaroi and Kurnai," obtained his first wife from Maneroi by elopement; he obtained his second wife from the Wurnŭngatti division of the Kurnai also by elopement, leaving his first wife with some friends during this proceeding. In addition to these cases, in which elder men obtained wives, or second wives, in Gippsland by (1) capture; (2) inheritance from deceased brothers (own or tribal); (3) by the rare cases of gift by the woman's relatives or by exchange of a female relative, will be found by those who desire to find the evidence in "Kumilaroi and Kurnai."

It is an error on the part of our critics to suppose that in Australia it is general, or even very frequent for the elder men to monopolise all the women. The young men acquire wives in various manners in various tribes, as by arrangement by relations, by exchange of sisters, by betrothal, by elopement, or as among some of the Kamilaroi tribes, by an absolute right of selection by the "initiated youth" of any unmarried girl of the proper class-name, provided his hands are free of the blood of her kindred.

It has been asserted by more than one of our critics that "the class-names as well as the terms of relationship are names merely, belonging to a system of personal addresses." Personal names are not in all Australian tribes secret names. In tribes within my knowledge personal names, class-names, totem-names, terms of relationship, are all used in addressing individuals. There is, therefore, no necessity in such tribes for individuals to have recourse to an invented system of fictitious relationships for the purpose of addressing each other, such as some of our critics believe in. The terms of relationship define groups, and the individual takes the name of his group. These groups have a real existence. For instance, in the tribe which occupied the table-land of Maneroo, it was the males of the two primary class divisions which met as two groups to mutually initiate their youths, that is, to confer upon them the privileges of manhood. It was the group "Jambi" of each intermarrying primary class-division which, under the control of the old men of the tribe initiated the youths of the other group. The youths being initiated are also "Jambi." It was one Jambi who gave a wife to the other Jambi, receiving his sister in exchange, and the relationship of Jambi included therefore "sister's husband" as well as "wife's brother"; but it was not imperative that the "sister" should be an "own sister," for she might be a "tribal sister." Jambi therefore represents a group; the individual takes the relationship of his group, and the relationship is a real one. We have here two exogamous groups of the social organisation of a tribe meeting to confer the rights of manhood on the youths of each, and each group providing the other group with wives. It is significant that in some tribes there is evidence that on such an occasion a temporary return to more or less intersexual communism between the groups takes place.

In conclusion, I may say that since the publication of "Kamilaroi and Kurnai," I have extended my inquiries over the greater part of Australia, and am still gathering information. The evidence has accumulated to a large extent, but I cannot at present foresee at what time it may be sufficiently completed for publication. I have therefore thought it well to make this statement, and also to say further that meanwhile I propose from time to time to summarise results in a series of short memoirs, the first of which I have presented to the Anthropological Institute, through the courtesy of Dr. Tylor. I must refer my critics to these memoirs, pending a final publication, for replies to their objections and for additional facts which it may be advantageous for them to consider. A. W. HOWITT

Sale, July 1

New and very Rare Fish from the Mediterranean

IN Prof. Giglioli's letter on rare Mediterranean fishes, which appeared in NATURE, vol. xxv. p. 535, he refers to specimens of *Scorpæna ustulata*, Lowe, obtained at Messina. In some "Notes on some rare and little known Fishes taken at Madeira," published between 1860 and 1870 in the *Annals and Magazine of Natural History*, I undertook to prove that the fishes on which Mr. Lowe founded that species were merely young specimens of the common *Scorpæna scrofa*, L. It might be well if Prof. Giglioli looked at the paper referred to before labelling his Sicilian fishes. With regard to the two Macruroid fishes, *Malacocephalus lævis* (Lowe), and *Coryphænoides serratus* (Lowe), which the Professor captured in the Mediterranean, I may state that they are so rare at Madeira, where they were originally detected by the late Mr. Lowe, that during thirty years I have only obtained a single specimen of the former and have never met with the latter at all. It would be curious if the "singular fish of a deep black colour, with small eyes, a naked skin, and a most abyssal physiognomy," should prove to be the rare Madeiran Gadoid, *Chiasmodon niger*, described by me in a paper read before the Zoological Society of London on November 10, 1863. The unique specimen was sent to the British Museum, but another example was afterwards taken in the West Indies, and figured by Dr. Carte in the *Proc. Z. S.* London, 1866, pl. ii. Singularly enough the stomach of the latter specimen contained a fish which exceeded the size of its swallower, and this was no other than an example of an extremely rare Madeiran species, *Neoscopelus macrolepidotus*, described by me in the *Proc. Z. S.*, January 13, 1863, pl. vii.

In enumerating the known species of precious corals in NATURE, vol. xxv. p. 552, Prof. Giglioli has not referred to the pure white species of Madeira on which Dr. J. E. Gray founded the genus *Hemi corallium*, the polyp cells being on one side of the branches, like the *Corallium secundum* of Dana. Only two specimens of this coral have fallen in my way, and one of these was presented to the British Museum. This was described with a figure by Dr. Gray in the *Proc. Z. S.* 1867, p. 394, Radiata, pl. xviii. See also his Catalogue of Lithophytes in the British Museum, 1870, p. 24. If this white coral could be found in greater abundance it would form a valuable article of commerce.

Madeira, August 26 JAMES YATE JOHNSON

Aurora

AN aurora of considerable proportions and of the radiant form was visible here on Wednesday night. At 9 p.m. the centre of energy was in the north-west, and from a large blunted cone-shaped smoke-like luminous mass in that quarter, fan-rayed streamers were projected to the zenith. The streamers were crossed at equal intervals by horizontal bars, similar in appearance, minus the motion, to the pulsating bars which sometimes form a feature of auroral activity. The day had been finer than has been the prevalent weather of late. Set of wind during the day, north-west. Drift of the clouds at high altitudes from south-west. The night calm, barometer high, thermometer 57. At 9 p.m. the western sky was covered with flocculent cirri. The north-west was obscured by the dense eruptive volume of auroral vapour. The northern sky was clear, and so was the eastern. The moon was shining brightly. The line between the auroral mass and the region of blue sky was remarkably sharp and well defined. Just after 10 p.m. a narrow streamer of great brilliancy shot from the north-west across the zenith to the north-western limb of the moon, constituting a notable feature of the display. As the night wore on, the centre of energy, together with the basal eruptive mass, travelled slowly northwards, and the northern sky became covered with bright white beams, rays, and streamers. At the same time, clouds of the cirrus type made a mackerel sky in the west, as well as in the zenith towards the south. Some of the streamers were of extreme tenuity, others were dense and bright, hiding the stars over which they passed. The sky in the end was covered with a light haze, which condensed into a cloud canopy. No prismatic colours were visible, streamers, beams, and rays throughout being alike of a pure white light, though greatly luminous, so as to retain distinctive individuality in the face of brilliant moonlight. Thursday, early morn, sun shining through a hazy sky, wind light from the south; 9 a.m., overcast; 11 a.m., rainfall set in. Continuous all the day. Sharp fall of barometer. Thermometer mid-day, 65, wind inclined to back to the eastward. Considering that the vernal and autumnal equinoxes are the usual periods of auroral activity, and that there is yet a month to the 21st of September, an instance, now of auroral energy is somewhat out of the usual course of things. The equinoctial gales, yet earlier, set in with much rigour. Perhaps, as everything has a meaning, these phenomena presage the kind of weather which is to rule the autumn. Scarcely a summer bird remains save the swallow and martin. The swift left early. A solitary bird or a pair was observed, however, evening by evening up to the 28th to return to the nesting place of the tribe, as loth to leave the English home. To day (Friday) continuous rain, which has prevailed all the night. Mid-day, thermometer 64; barometer 29·3; set of wind southerly. X.

Worcester, September 1

Habits of Spiders

YOUR correspondent, Mr. Frank Rowbotham, in his letter on the "Habits of Spiders" (vol. xxvi. p. 386), gives it as his opinion that a spider shakes the web from a desire "to effect concealment when it feels danger is near." I am inclined to think it does so from a feeling of anger. During a long residence in the tropics, I often amused myself irritating spiders and watching their conduct. I noticed that they generally seized the web and shook it up and down in the manner described by your correspondent, but some of the spiders were of so great a size as to render concealment by such a manœuvre quite hopeless, and I attributed their behaviour to other motives. They appeared to me more to resemble angry monkeys than anything else. I have not unfrequently seen the latter when annoyed jumping up and down on all fours with their tails erect in the air, or if confined in a cage seize the bars bp their hands and feet and shake them as the spiders did their webs. W. J. C.

Torquay, August 30

THE RESPIRATORY MOVEMENTS OF INSECTS

THE respiratory movements of some of the larger insects are quite apparent, and have been described by various observers. A German naturalist, Herr Rathke, published in 1861 a memoir in which he compared those movements, observed with the naked eye and a magnifying glass, in insects of all the principal types.

According to M. Plateau (who has lately studied the subject, and has made a preliminary communication of his results to the Belgian Academy), though Rathke's memoir is very remarkable, he overlooked many details, and fell into sundry errors, owing to the difficulty of the inquiry.

Haussmann (1803) suggested a method of indicating the movements of dilatation and contraction of an insect's abdomen, by oscillations of a liquid column; but he recognised that it would apply only to articulata of large size, and it seems incapable of yielding very exact results.

M. Girard (1873) proposed encasing the insect's abdomen with a thin envelope of caoutchouc having a style attached which would inscribe the movements.

It is a form of the graphic method that M. Plateau first adopted. He confined himself to perfect insects, and directed his attention to (1) the form of the inspiration and expiration; (2) the parts of the body participating in the respiratory movements; (3) the expiratory and inspiratory muscles; (4) the influence of certain parts of the nervous system on the movements of respiration. The technical processes concerning the muscles and nervous system are a matter of mere dissection, once the form of respiratory movement is ascertained, and the latter, therefore, chiefly claims notice in a simple *résumé*.

M. Plateau used two kinds of styles to inscribe the movements on a rotating blackened cylinder. One was a narrow light strip of Bristol paste-board, fastened to the part of the body whose movement was to be ascertained, with a little Canada balsam; the other a lever of the third order, turning freely about a horizontal axis placed at one end, and resting by its own weight, at a point near the axis, on the body of the insect (the insect, in either case, being supported fixedly in any desired position).

The graphic method is, however, unsatisfactory, and sometimes quite inapplicable, and M. Plateau used another along with it, viz. the method by projection, which gave excellent results.

The insect, fixed on a small support, so that the movements in breathing are not interfered with, is introduced into a large magic lantern lit with a good petroleum lamp. A reversed silhouette is obtained on the screen, and if a certain magnification be not exceeded (say 12 diameters), a very distinct image is produced, on which one may follow all the respiratory movements sufficiently amplified to indicate real displacements of a fraction of a millimetre. With a sheet of white paper over the image one draws the contours of the silhouette, corresponding to expiration and inspiration. Further, by changing the position of the insect, and by attaching short paper styles at parts whose movements are doubtful, a complete knowledge may be acquired of all details of the respiratory movements that characterise a given insect.

With a little practice, not only may the respiratory movements of small insects, such as flies, be easily studied thus, but a number of questions are unmistakably settled, which cannot be decided by direct observation.

The following is a brief *résumé* of the author's results:—

1. There is no close relation between the form of the respiratory movements of an insect, and the insect's place in zoological classifications. The respiratory movements are similar only when the structure of the abdominal rings and the arrangement of muscles moving them are nearly the same. Among curious facts here, the movements of Phryganeidæ are unlike those of nearly related Neuroptera (such as Sialis), and like those of sting-bearing Hymenoptera.

2. *In all insects* the diameter of the abdomen diminishes in expiration by approximation of the dorsal and sternal arches of the segments; in some cases the dorsal, in others the sternal, showing the greater mobility; and in others both having nearly the same mobility.

3. The modifications in the vertical diameter *may* be accompanied by changes in the transversal diameter (*e.g.* Libellulæ).

4. Contrary to a former view, the changes of length of the abdomen, in normal respiration, by protrusion and return of the rings, are rare in insects; they are observed in an entire group only in the case of the sting-bearing Hymenoptera. Some isolated cases occur in the other zoological subdivisions (*e.g.* the caddis flies among the Neuroptera).

5. In the majority of cases, the thoracic segments do not participate in the respiratory movements of insects at rest. But the respiratory displacements of the posterior rings are less rare than Rathke supposed.

6. It has been thought that the respiratory movements in many insects were progressive, and propagated like a wave either from the base of the abdomen towards the point, or from the middle towards the two ends. This wave is, however, an exceptional phenomenon, is absent in all Coleoptera, in Acridians, in Libellulæ, in sting-bearing Hymenoptera, in Muscides, and a part of Lepidoptera, and only appears in isolated forms in certain groups.

7. When there is a pause in the respiratory phrases it always occurs in inspiration.

8. In all insects vigorous enough to furnish suitable curves (such as the large Coleoptera) one finds that the inspiration is usually slower than the expiration, and that the latter is often sudden (confirming an observation by Sorg in 1805).

9. In most insects expiration is alone active, inspiration being passive, and due to elasticity of the teguments and the tracheal walls. (This confirms previous observations.)

10. Nearly all insects possess only expiratory muscles. M. Plateau has found muscles aiding inspiration not only in Hymenoptera and Acridians (Rathke, Graber), but in Phryganeidæ.

11. The superior and inferior diaphragms of Hymenoptera have not the *rôle* Wolff attributes to them (a confirmation of objections by Graber).

12. Many insects, perhaps all, perform, with their abdomen, general movements, sometimes small, sometimes very ample, which do not coincide with respiratory movements, properly so called, and must be distinguished from them.

13. The respiratory movements of insects are purely reflex, persisting in the decapitated animal, and even in the isolated abdomen in forms whose nervous system is not condensed. In the latter case these movements are excited or retarded by the same causes which excite or retard them in the intact insect (a confirmation of previous observations).

14. The metathoracic ganglions are not, as Faivre supposed, special respiratory centres (a confirmation of the views of Barlow and Baudelot on Libellulæ).

15. The abolition of respiratory movements by destruction of the metathoracic ganglions in Dytiscidæ and other Coleoptera, results from the condensed state of their nervous system, in which a certain number of abdominal ganglions are fused with those of the metathorax.

16. In insects with a condensed nervous system the excitation or partial destruction of a complex nervous mass resulting from the union of successive ganglionary centres always affects all the centres entering into the constitution of this mass.

DIARY OF VESUVIUS, JANUARY 1 TO JULY 16, 1882

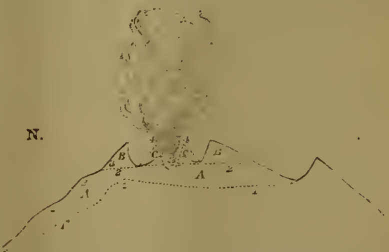
IN the account given in NATURE, vol. xxv. p. 294, the eruption that has been going on in December was described up to the last day of 1881. As the height of the lava column had been diminished by the lateral outlets, the surface was consequently some considerable distance below the lip of the crater, its level on ordinary occasions being only a few metres below.

Under ordinary conditions the ejectamenta consist of masses of fluid lava blown out as the spray from an effervescing liquid. They form the so-called lava cakes, being flattened out by their fall, while still plastic. They are usually very spongy, or scoriaceous, and rapidly disintegrate. In the present instance, however, as the vapours quitted the lava at some considerable depth, these plastic masses could not reach the surface. This rapid escape of vapour through the narrow tube between the lava surface and the crater lip, was under analogous conditions to the powder gas in a fire-arm. If, for instance, we imagine a cannon, whose bore is composed of materials easily broken up, we have a rough illustration of what takes place. The lava-cakes were replaced by ejectamenta derived from the components of the sides of the chimney, such as compact lava fragments, lapilli, old scoria cakes, all more or less altered and decomposed by the hot acid vapours, to which they had been exposed for considerable periods.

Such a condition of things naturally results in the straight-tube or chimney assuming the form of a funnel, or conical hollow whose apex will be at or near the lava level, that is to say, at the point where the gaseous products quit the fluid magma. We have, in fact, two conditions upon which the size and depth of a crater depend, namely, height of lava column, and amount and force of vapour escaping. Naturally the effect would be modified by local causes, and also the difference of component materials. The ejectamenta which in this manner were very different from that of ordinary occasions, were deposited simultancously in a rim-like manner around the new crater.

Sketch after Nature on July 16, 1882, 9.30 a.m. View from the north of the cones and craters of December, 1881, and January to July 16, 1882. The outer rim is broken away over the old fissure to the left or east. The smaller bocca is beneath the little figure, there is probably the remnants of another beneath the middle, or left figure.

Thus we see how a nearly perfect cone of eruption, such as existed in the beginning of December, composed as it was of alternate beds of lava and scoria cakes, with a chimney, but without a crater, may be converted into a low truncated cone, whose base is of an area considerably larger than that of the original, but whose height is much less. The interior now occupied by a crater proportionally large. The whole of these changes occurring without the addition or abstraction of any materials, except an ash blown away by the wind.



1, Outline profile of apex of cone after eruption of 1872; 2, outline on December 31. 1881; 3. outline section on April 23. 1882 (*i.e.* the continuous line); 4. cone and crater formed between April 23 and July 16, 1882; A, materials, lava, and scoriæ since 1872; B, ditto, since December 31. 1881; C, ditto, since April 23. 1882.

On January 1, Vesuvius had become quiet, and the feeble ejections consequent thereon could no longer hoist the materials over the new crater edge, but were instead building up a new cone of eruption around the vent at the bottom of the craterial hollow.

Till January 14 no glimmer even was visible from Naples. On that evening, however, there was a slight red reflection, which continued till the 24th, when much vapour was escaping. The next day it became quiet.

February 2, slight glimmer visible again.

From February 19 to April 23, the mountain remained very quiet; only the slightest glimmer visible at night. That day I visited the crater.

The crater and its rim of December and January occupies about one-third of the plain of lava filling the 1872 crater. The former overlaps the latter in a north-east direction, and is not therefore concentric. As we cautiously mount its northern edge to avoid the falling scoria cakes, it is seen that the craterial hollow has very steep sides, about 40 metres deep, and 150 metres in diameter. It showed the usual interlamination of lava and its fragmentary products. Rising from its floor was a small cone of eruption, that had been building up since the beginning of the year, its centre, of course, occupied by the vent, but no crater. The fissure mentioned in my last report was gradually filling up by the crumbling in of its sides; there was still oozing a small stream of lava from its lower extremity. This gentle flow of fluid rock had been going on without interruption since December, and during that period had been thrown out to a considerable amount, which, however, from slow exit soon cooled and had not enough impetus to travel far, chiefly piling itself up at the toe of the cone, and spreading a short distance over the Atrio and Valle dell' Inferno.

On May 13, became slightly more active, which continued till the 17th, the day of the eclipse of the sun. On that evening the reflection was very brilliant from a much increased flow of lava on the same side. From May 18 till June 6, gradually diminishing activity, especially during the last week. During the 4th and 5th, Prof. Palmieri recorded a continued uneasiness, as shown by the Vesuvian Observatory and University seismographs. That disturbance was the forerunner of a sharp earthquake shock, which occurred at 4·47 a.m. at Isernia and Vinchiaturo in the Appenines. At 8 a.m., when I scanned the crater with a glass, there seemed to be an increased volume of vapour from the fumaroles, and the main column was much more bulky and dense. In the evening the explosions reached a considerable height, and were very brilliant. On the 7th the same, but on the 8th quieter.

We have here a small but good example of seismic energy exhibiting its focus of intensity in a mountain range, yet at the same time setting up sympathetic activity in the neighbouring volcano. In fact, I believe that if more accurate and regular observations were carried on of earth tremors and the phases of volcanic activity, at many points scattered over such a country as Italy, much might be learned of the internal anatomy and physiology, so to speak, of such an area.

I say Italy in particular, for many reasons. The principal, however, are its simple structure, thus avoiding the various complications that must necessarily arise if its geology were very intricate. Again, the history of many of its principal seismic events are far more complete and extend farther back than that of any other country. In fact, we may look forward to the time when seismology and vulcanology will be placed on much the same basis as meteorology, and probably with equally important results.

The mountain from the last date to the 29th remained tranquil, no reflection being discernible at night. That evening, however, the ejections were to be seen distinctly. The following day it was the same, but on July 1 the activity had increased, and the lava that had now been arrested for weeks burst forth again at its old exit.

The mountain now took on somewhat an intermittent phase. On the third it was quieter, 4th the same, 5th, 6th, and 7th more active, 8th, 9th and 10th quieter, 11th and 12th more active, 13th, 14th, and 15th quiet.

On July 16 I made a minute examination of the crater. Owing to a favourable wind, and with a muffle over the face, the edge of the innermost one could be reached. This, on which we were standing, was the cone of eruption that was commenced to be formed, in the bottom of the December crater, and whose growth had been going on up to June 29, when the increased activity of that and the following days, converted the top of the chimney into a small crater, at the same time scattering the materials on its outer flanks and increasing the size of the cone. The cavity, of an irregular conical form, was about 45 metres deep, and its apex could have been but little above the level of the outflow of lava that was still proceeding from the old lateral fissure. At the bottom of the crater was the bocca or mouth. Its position was slightly excentric, and irregular in form, being about 2×3 metres. It was apparently undercut by the lava that could be distinguished boiling up at a short distance from its edge, the issue of the ordinary column of vapours, carrying with each explosion a few fragments of the plastic mass, thus commencing a fourth cone within the inner crater. Part of the southern wall had crumbled away, showing well the stratification of the beds.

Between the inner cone of 1882 and that of 1881, that is to say, in the fosse-like excavation separating the two, and towards the south-west (below smallest figure in sketch), another bocca had opened. From 9 to 10 o'clock a.m., during which my examination had been carried on, only an abundant column of vapour had been emitted. When standing quite close to it, however, it suddenly started into increased activity, emitting a column of ash and lapilli, perpendicularly to some height, reminding one in form of the great geyser column of Iceland. This was due to the slipping of a part of the outer wall, which exhibited the stratification of the December cone. A continual play was maintained for about one hour and a half, when tranquility was restored. Mixed with the stones and lapilli that were being ejected were a few fragments of molten lava, demonstrating the opening to be in direct communication with the principal mass. Although one could approach the edge of the opening nothing could be seen, for the amount of vapour issuing. On that occasion the usual hydrochloric acid smell was strong but mixed with a little sulphurous, and I fancy I could detect a distinct odour of hydrofluoric acid, which is the first time. Of course it is known to exist in small quantities always.

The old lava forming the plain within the 1872 crater, and from which rise the two small cones above described, is much decomposed and covered by fumaroles, in a direction extending due south-west, that is to say, scattered along the same radius as the crateret above mentioned. It would seem from this to be the external evidence of a dyke which has extended in that direction. We might therefore infer that if any lateral opening should soon form it would be somewhere on the south-west of the cone.

H. J. JOHNSTON-LAVIS

THE HUNGARIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

BUDAPEST, *August* 28

THE twenty-second meeting of the Hungarian Association for the Advancement of Science has just been concluded. It was held at Debreczin a town of 52,000 inhabitants, and the capital of the great Hungarian Plain. Two hundred and eighty members were present, and of these 132 joined the Medical Section, while the remainder were divided pretty evenly between the Physical and Economic Sections. The Physical Section includes Chemistry, Mathematics, and Astronomy; and the Economic Section includes matters relating to Social Science and Agriculture. Unfortunately the Association does not represent Hungarian science. There is a strong University party in Budapest opposed to its existence; and they give it no countenance either by their presence or otherwise. Nevertheless we are persuaded that the influence of the Association is good.

Debreczin is a great Calvinist centre. It has been called the "Rome of Calvinists." There is a Calvinist College which educates nearly 2,000 children, boys, and young men. Roughly there are 2,000 Calvinist parishes in Hungary, containing 2,000,000 souls, and of these 560 parishes and 800,000 souls are under the jurisdiction of the Bishop of Debreczin. The Bishop was President of the Association and the Sectional Meetings were held in the College. Great toleration exists in religious matters throughout Hungary, and the Calvinist Bishop and Roman Catholic Præpostor entered the Hall together and sat next to each other during the delivery of the Presidential Address.

On the evening of the first day of meeting, the train from Budapest which conveyed a number of members, was met at the station by the town authorities, and an address of welcome was delivered. We then went to the Town Hall, registered our names, received various publications including a fine volume giving a complete history from every point of view of the town, which has cost the municipal authorities 6000 florins. In the evening we all dined together. On the following day the Presidential Address was delivered at 10 a.m. This was followed by the reading of letters of salutation from various parts of Hungary. A paper was then read by Prof. Török one of the Vice Presidents on the Meteorites of Hungary, and specially on the Kaba meteorite which fell near Debreczin in 1857. This was the period of the Austrian domination. and many meteorites had already been taken from Hungarian museums and transferred to Vienna. A demand was at once made for the Kaba meteorite to be similarly transferred, but the Debreczin authorities answered, "It is true that you have a right to everything on and beneath the earth of Hungary, but this came from Heaven. Hence we propose to keep it here." And it remains in the Debreczin Museum. After the meteorite paper an eulogium was pronounced by Dr. Popper on Dr. Albert Kain, a recently deceased and prominent citizen. A short paper on children's diseases was then read by Prof. Bódogh, and the proceedings terminated at 1 p.m. Soon afterwards the members sat down to a public banquet of a very festive nature, which lasted till nearly 5 o'clock, and was notable for the national dishes, and profusion of native wines and mineral waters; of the latter Hungary possesses no less than *eighty* different varieties.

At 5 o'clock a lecture was given by Dr. Kiss on Hatvani, a professor of physics in the Debreczin College of the last century. He studied in Leyden and was the first to introduce experimental illustration into the college lectures. A good deal of his apparatus was exhibited and the air-pump with a huge horizontal barrel two feet in length and three inches in diameter, was particularly interesting. In principle it scarcely differed from Robert Boyle's second air-pump of the preceeding century.

At 9 a.m. on the following day the three sections were formed, and addresses delivered by the Presidents. The Physical Section was presided over by Prof Hunfalvi of Budapest, and his address was mainly devoted to the Meteorology of Hungary. He dwelt particularly on the great evils resulting from the cutting down of forests, and the climatal changes likely to result therefrom. As wood is commonly burnt for fuel in Hungary, and the winters are very severe, the destruction of forests is proceeding at a great rate. The address was considered of such importance that it was ordered to be printed separately and distributed all over Hungary. The Medical Section was presided over by Prof. Török, and the Economic Section by Prof. Kiraly. The meetings closed at noon, and recommenced again at 3 p.m. At 5 to a very crowded audience Prof. Antolik gave a lecture on the electric discharge, with some original experiments.

The Sectional Meetings were continued the next day and in the afternoon an excursion was made through the Debreczin Forest to an Agricultural College founded by the Government for the instruction of land agents and managers of large estates. The course extends over three years, and the students pay nearly £21 a year. The institution is a large model farm possessing a good deal of land, and very complete farm buildings in which fine breeds of cattle, horses, and pigs are reared. The bulls and horses are of particularly fine breed. In returning we halted at a forest hotel, dined, and afterwards danced, the national *Csárdás* being of course the most popular. Sectional meetings were continued during the following day, and on August 27 the closing meeting was held. In the afternoon there was an excursion to the salt lakes of Nyiregháza.

The invitations were written in Latin, as of course Hungarian is a language, not much known out of the country. They were worded as follows:—

"Doctores Medicinæ et naturæ scrutatores Hungariæ, hoc anno Debrecini a 20-27 Mensis Augusti, Congregationem Scientificam sunt celebraturi.

"Cum ad hoc Congregationem D. . . . M. . . . N. . . . solemniter invitaremus, simul impense, rogamus, ut nos gratissima sua præsentia honorare, vel aliis hunc honorem delegare, congregationisque medicorum et naturæ scrutatorum in cognoscendio rerum causis positum studium favore et si lubet opera prosequi non dedignetur.

"Dissertationes de naturâ rerum agentes, secundum statuta congregationis, quâcunque linguâ haberi possunt.

"Sincerissimam quam possumus salutationem exhibentes perseveramus. Debrecini, 4 Mai, 1882."

A few years ago Latin was commonly spoken by educated Hungarians, and Latin words are now frequently used in intercourse with foreigners. One morning when I was looking for my host, his little son gravely gave me a letter which he had rapidly penned, expressed with the following charming naiveté:—"Domine Professor! Meus pater est in Collegio. Si Vestra Dominatio alloqui illum vult, voco statim domo. Hora nona certe redibit." And while on the subject of colloquial Latin in this country, we are fain to remember the story of the English sailor, who was rolling a gigantic piece of tobacco in his mouth, to whom a Hungarian, unused to the custom said, pointing to the distended cheek, "Quid est hoc?" whereupon the sailor answered readily, "Hoc est quid."

It is impossible to conclude this short notice of a very interesting scientific meeting, without mention of the extraordinary cordiality and hospitality of the town of Debreczin.

G. F. RODWELL

THE BRITISH ASSOCIATION

THE number of papers in the two leading departments of the Biological Section were very few this year, as indeed they have been for some years, and therefore it was decided by the General Committee that the number of departments of that section be reduced from three to two. Next year's meeting was fixed for September 19, with the view of bringing it towards the close of the holidays rather than in the middle of them. A formal resolution was also passed authorising the Council to make the best arrangements they can for securing an equal representation of all the sections at the meeting proposed to be held at Montreal in the succeeding year. One or two speakers seemed to doubt whether the matter could be regarded as finally settled. A suggestion was made that a meeting should be held in this country as usual, and that the vice-presidents should go to Canada as delegates. It was stated on both sides that members were absent at Monday's meeting whose votes would have materially affected the decision arrived at. It is matter of satisfaction that Southport contains numerous public meeting-places close to each other. The scattered position of the Sections at the present meeting has been a very serious obstacle to members wishing to hear papers in different Sections on the same day. This has been especially the case in Section C, which, being half a mile from most of the other Sections, seldom obtained a good audience, and indeed was only filled when the popular subject of the Channel Tunnel was brought before the Section by Messrs. Boyd Dawkins and De Rance.

REPORTS

Report of the Committee consisting of Prof. Roscoe, Mr. Lockyer, Prof. Dewar, Prof. Liveing, Prof. Schuster, Capt. Abney, and Dr. Marshall Watts, appointed at the York Meeting to prepare a New Series of Wave-lengths Tables of the Spectra of the Elements.—This Committee report that they have lately obtained an instrument for the more exact performance of the process of graphical interpolation, constructed by Messrs. Cooke and Sons of York. And since this instrument has only been received within the last few weeks they are not in a position to make a detailed report to the Association.

The Report of the Committee consisting of Prof. Balfour Stewart, Thorpe, and Rücker, appointed at the York Meeting to Report on Methods of Calibrating Mercurial Thermometers was read by Prof. Rücker. Thermometer tubes are in general of unequal bore in different parts, and the indications of the instruments will thus be erroneous, unless these irregularities are allowed for. If a short column of mercury broken off from the main mass in the bulb and tube be measured in different parts of the tube, its length will be greater in the narrower, and less in the wider parts. By means of such measurements the correction for the inequalities in the bore can be applied in two different ways distinguished as methods of calibration and correction respectively. In the first the length of the column of mercury is measured in various parts of the tube before the scale is etched on it, and the lengths of the divisions are then so adjusted as to make equal differences of scale readings correspond to equal volumes. In the second the tube is in the first instance furnished with a uniform scale, and a table of corrections is afterwards drawn up, by means of which the same end is attained as before. In either case the measurements have to be made in some systematic manner, and a number of different methods of performing the observations and calculations have from time to time been proposed. That in use at the Kew Observatory is the simplest of all, while the more elaborate methods have for the most part been proposed by German writers. The report consisted of a minute discussion of the relative merits of these various methods, the chief of which had been applied by the Committee to the same thermometer, so that the results could be readily compared. The measurements for this purpose were made in the Physical Laboratory of the Yorkshire College. The methods chiefly investigated were Gay Lussac's, Hällström's, Thiessen's, Marek's, Rudberg's, and Bessel's, both as modified by von Oettingen, and also with further modifications introduced by Professors Thorpe and Rücker. As the result of a long theoretical and experimental investigation, the Committee conclude that labour is saved and equal accuracy secured by the repetition of the simplest method of correction (Gay Lussac's), instead of the employment of more elaborate and theoretically more perfect schemes.

Report of the Committee, consisting of Professors Odling, Huntington, and Hartley, appointed for the Purpose of investigating, by means of Photography, the Ultra-Violet Spark-Spectra emitted by Metallic Elements and their Combinations under Varying Conditions.—This report was drawn up by Prof. Hartley, and communicated to the Section by Prof. Huntington. The object of this investigation was to give, first, a means of readily identifying the metals by photographs of their line spectra; secondly, a knowledge of the alterations producible in the spectra of metallic salts by the presence of various non-metallic elements; thirdly, a knowledge of the alterations caused by the dilution of metallic solutions; fourthly, a possible means of performing rapid quantitative determination of metallic substances by the aid of photography, and obtaining permanent records of the results. These objects have been more or less completely attained, and the results obtained have been the subject of two communications to the Royal Society, which contain an account of the elucidation of the following points:—(1) The solution of the practical difficulty of obtaining photographs of spark spectra of metallic salts from their solutions; (2) the comparison of spectra yielded by metallic electrodes with those obtained from saline solutions; (3) the variations in the spectra caused by dilution of saline solutions; (4) the sensitiveness of spectrum reactions under certain conditions; (5) the variation in the spectra of metals caused by alterations in the intensity of the spark employed. A comparison of the spectra of solution of salts with those of metallic electrodes show that in almost all cases the lines of the metals were produced from the solutions. The non-metallic constituents of salts do not yield any marked series of lines. The spectrum of aluminium, as obtained from pure solutions, is free from a group of short or discontinuous lines, which the author has shown to be due to iron. In estimating the relative proportions of the constituents of alloys or minerals, only those methods are to be recommended in which solutions are used, as in this way the non-homogeneity of the substance under investigation can alone be obviated. With regard to the reversal of metallic lines, it is pointed out that over-exposure suffices to produce reversal without materially influencing the rest of the spectrum; and in order to obviate this result, it is recommended that comparative exposures should be methodically employed to confirm the accuracy of observations made entirely by the aid of photographic representations and of spectra. This is especially the case where gelatine or other dry plates containing organic matter are employed.

Report of the Committee on the Lunar Disturbance of Gravity, by G. H. Darwin.—Shortly after the reading of the first report last year at York, it was found that the instrument with which he and his brother had been working, had broken down, and this together with a series of unforseen circumstances, had prevented their continuing their observations. But he still had some remarks to make on the subject. From a remark made by Signor de Rossi on an observed connection between barometric storms and the disturbance of the vertical, he had been led to make some investigations on the mechanical effects caused by variations of pressure acting on an elastic surface. When a heavy body rests on the surface of the earth in the neighbourhood of a pendulum, the direction of the pendulum, or the vertical, appears to change, a change due to two causes: first, an actual change due to the attraction of the heavy body on the bob of the pendulum; and secondly, an apparent change due to an actual change of level caused by the elastic yielding of the surface. Sir W. Thomson had pointed out to him a very remarkable relation between those two effects. If a heavy mass of any form be placed on the surface of an elastic plate of great thickness, the deflection produced on a plumb-line suspended over any point of the plate by the attraction of the mass is proportional to the slope produced in the plate at the same point by the elastic yielding to the mass. Applying this to the case of variation of barometric pressure, and supposing the earth to have a rigidity between that of glass and copper, he found that the variation of slope between two places 1500 miles apart due to a difference of 5 cm. of barometric height would be 0″·0117, whilst if the attraction of the air be included, it would amount to 0″·0146. Thus, considering two cases of high pressure to right and left, there would be a difference in the position of the plumb-line relatively to the earth's surface of 0″·0292. The amplitude of oscillation at Cambridge due to lunar disturbance of gravity, as computed on the hypothesis that the earth is rigid, was in last year's report shown to be 0″·0216, whilst the instrument was capable of detecting changes of 0″·01. As these quantities were all of the same order of magnitude, he came to the conclusion that it was hopeless to expect determinations of the lunar effect by experiment based on the pendulum method. There was another effect due to change of barometric pressure, viz an alteration in the altitude of the surface. Under the same circumstances as above the difference in height at the two places would be 9 cms. The same reasoning applied to the tides would show that there would appear to be a greater rise and fall of tides that actually exists. This effect is in the opposite direction to that due to the elastic yielding of the earth on account of the tide-rising forces of the sun and moon. Near a coast line the apparent change of the vertical between high and low tides would be far more considerable than in the case of variation of barometric pressure. With a difference of true height of water between high and low tide of 40 cm., and with a tidal wave-length of 3900 miles, the change in slope at a distance of 1 kilometre from the water's edge would be 0″·076.—Sir W. Thomson pointed out a method by which the effect of the attraction of the observer in Mr. Darwin's experiments might be determined independently of the deviation produced by the elastic yielding of the earth due to his weight. He also suggested that Mr. Darwin should apply the same reasoning to discuss the phenomena of seiches, such as have been observed by Forel on the Lake of Geneva.

Report of the Committee on the Present State of Spectrum Analysis (drawn up by Dr. Schuster).—The report consists of three parts. In the first part the question is discussed whether any numerical relation between the different periods of vibration of one molecule can be traced. The result of several investigations seems to be that though the different vibrations are connected according to some unknown law, they are harmonics only in exceptional cases. The second part of the report considers the question whether a connection exists between the spectrum of a compound and the spectrum of the elements which make up the compound. The investigations of Dr. Gladstone are referred to, since confirmed in many instances, in which he has shown that coloured acids, as chromic acid, when combined with different bases retain their own absorbing properties. The same applies to coloured bases. But as Dr. Gladstone himself points out, the law is by no means a general one. The curious observations of Bunsen's on the absorption-spectra of didymium salts are discussed. Bunsen has shown that their spectra are all very nearly alike, but slightly displaced either towards one or towards the other end of the spectrum. Capt. Abney and Col. Festing's observations on the absorption in the infra-red are referred to at length, and the connection between the luminous spectra of such bodies as the chlorides, bromides, and iodides of the alkaline earths is discussed. In the last part of the report the similarity of the spectra of similar bodies is pointed out, but no numerical connection has as yet been found.

Report of the Committee, consisting of Lieut.-Col. Godwin Austen, Dr. G. Hartlaub, Sir J. Hooker, Dr. Günther, Mr. Seebohm, and Mr. Sclater, appointed for the purpose of investigating the Natural History of Socotra and the adjacent Highlands of Arabia and Somali Land—The balance in hand from 1870-1 (6*l*. 7*s*. 10*d*.), added to the 100*l*. granted at the York meeting, together with the amount received up to the present time by the sale of the duplicate specimens of birds and land shells, viz. 17*l*. 12*s* 4*d*., reduced by 7*s*. for postage, leaves a total balance in hand of 143*l*. 13*s*. 2*d*. for any future work on the Socotra or in the adjacent mainland.

Since the last report was presented Prof. I. Bailey Balfour has been working whenever his other duties permitted at the extensive botanical collection formed by him, to which must be added the plants collected by Schweinfurth, who has since visited the island, and who has placed the same most liberally at Mr. Balfour's disposal. Some of the preliminary diagnoses have been published, which show that the different groups are very rich, and that there is a very considerable amount of work in the collection which can only be brought out slowly. Prof. Balfour hopes to give a short report on what is completed at this meeting. Writing on June 17 he says:—"I have a lot more diagnoses in press just now, and hope in August or September to complete my work on the Botany. This *émeute* in Egypt will, however, interfere, as Schweinfurth will be unable to continue his communications, and I am waiting for a lot of notes by him on many species. I only hope his collections will not be destroyed, and as he has some of my specimens at present I am somewhat anxious regarding their fate." . . .

The rock-specimens collected by Prof. Balfour have been worked out by Prof. Bonney, whose report on the subject was read before the Royal Society at their last meeting of the present session. He states that the great limestone plateau, which forms so large a part of the upland district of the island, is found by the Foraminifera present in the rock to be of Miocene age. This is seen to rest in many places upon a floor of very ancient gneissic rock, bearing a general resemblance to the most ancient rocks of north-western Britain and other countries. The Haggier mountains, forming the highest ground in the island, consist, so far as is shown by the specimens brought, of granites poor in mica and rich in felspar, bearing often a considerable resemblance to those of Sinai. These are traversed by dykes of felsite and other igneous rocks. To the south-east of this range is a tract occupied by red felsites and rhyolites, with some agglomerates or conglomerates. The structure of some of the former rocks renders it in the highest degree probable that they are ancient lava flows. They are anterior in date to the Miocene limestones. These also are occasionally cut by basalts and perhaps trachytic rocks. In the northern part of the island, beneath the limestone, is an argillite of uncertain age, and there is probably some representative of the "Nubian sandstone." It is, however, almost certain that for a long period anterior to the Middle Tertiary, Socotra formed part of a land surface, and it is quite possible that the summits of the Haggier mountains may not have been even then submerged. If so ,the flora, and perhaps the fauna, is likely to have an exceptional interest.

As to a renewal of explorations, the Committee fear that Eastern affairs make the outlook very unsatisfactory, and it would appear all through the East, in the vicinity of Aden especially, there is a very hostile spirit rampant against Europeans. It is hoped that there may soon be some definite settling of the excitement, but at present the Committee do not think that any plans for a future expedition can be made.

The results of the Socotran exploration have been so successful and so great, considering the small expenditure of money and time it entailed, that the Committee trust they may see the same kind of work extended. They trust that the opportunity will not be lost of sending properly trained naturalists into the mountainous regions of Eastern Africa, which the despatch of an expedition by the Geographical Society now presents. The scientific knowledge that would be accumulated by such explorers in such conditions as that lofty region offers would be of immense value, and not of secondary interest or importance to purely geographical information.

The Committee do not, therefore, ask for any further grant at present.

Report of the Committee, consisting of Mr. James Heywood, F.R.S., Mr. William Shaen, Mr. Stephen Bourne, Mr. Robert Wilkinson, the Rev. W. Delany, Prof. N. Story Maskelyne, M.P., F.R.S., Dr. Silvanus P. Thompson, Miss Lydia E. Becker, Sir John Lubbock, Bart., M.P., F.R.S., Prof. A. W. Williamson, F.R.S., Mrs. Augusta Webster, Rev. H. W. Crosskey, Prof. Roscoe, F.R.S., Prof. G. Carey Foster, F.R.S., and Dr. J. H. Gladstone, F.R.S. (*Secretary*), *appointed to watch and report on the workings of the proposed revised New Code, and of other legislation affecting the teaching of Science in Elementary Schools.*—When this Committee was re-appointed at York, it was with a special view to the important changes which it was expected the Government would make in the Education Code. In the postscript to their previous report, great satisfaction was expressed at the general scope of the "proposals" that had just been submitted to Parliament, but it was urged that the knowledge of nature should be more effectually encouraged as a class subject.

On assembling in the autumn, your Committee added to their number the Rev. H. W. Crosskey of Birmingham, and Prof. Roscoe of Manchester, and, subsequently, Prof. G. Carey Foster of London.

At the first meeting it was determined to enter into communication with Mr. Mundella, the Vice-President of the Committee of Council on Education, but the serious illness of that gentleman caused a delay. The Secretary, however, eventually saw him at his own house, and found him desirous of receiving the views of the Committee by deputation. As this was a step which your Committee felt themselves not justified in taking unless through the governing body of the Association itself, they drew up a series of resolutions, and submitted them to the Council, with the request that that body should appoint a deputation to urge their views.

These resolutions were passed by the Council, with the addition of that numbered VII. They were as follows:—

I. That Clauses 9 (3), 20, 26, and the Standard work in Geography (pp. 6 and 7) be approved.

II. That the arrangements involved in Clauses 18, 19, 21, 23, and 27 be subject to revision on the following grounds:—

a. That Clauses 19 and 21, read together, will practically exclude Elementary Science teaching in the Lower Division, as Geography will be almost always chosen by teachers as the second subject.

b. That placing Standard IV. in the Lower instead of the Upper Division will restrict the choice of Class-subjects to be taught in that Standard, and altogether exclude the teaching of any of the Specific subjects.

c. That, taking all these Clauses as they stand, there will practically be a cessation in the teaching of Elementary Science from the time of leaving the Infant School (Clause 9 (3)), till entering the Upper Division (Clauses 23 and 27).

It is therefore recommended that Clause 21 be left out; and that Clause 19 be so modified as to permit of the ordinary Class Grant being paid if the children pass in any one or two of the Class subjects, and an additional Grant if three be taken.

III. That the list of Specific subjects (Clause 25) should include Elementary Physics, and the fundamental facts of Chemistry; and the word "Geometry" should be used instead of "Euclid."

IV. That Clause 29 be left out, inasmuch as Domestic Economy includes the principles of alimentation, sanitation, &c.

V. That the teaching of Specific as well as Class-subjects in Night Schools should be provided for in Clause 30.

VI. That the Standard work in Elementary Science (pp. 6 and 7) needs re-arranging:—

The division (*a*) should generally include plants as well as animals.

The divisions (*b*) and (*c*) should be welded together, and more progressively arranged.

VII. That the Science programme should be regarded as a suggestion, but not necessarily as an inevitable arrangement.

VIII. That the Pupil Teachers' course (p. 11) shall provide for the study by them of Elementary Science, seeing that they will in all probability be required to give 'Object lessons, or to teach Elementary Science in the Schools, and to attend science classes at College.

A deputation was appointed to present the memorial, but so many other public bodies were approaching the Education Department on the subject of the New Code, that Lord Spencer was unable to find time to receive it, and the memorial was sent in the usual way. Dr. Gladstone, however, as one of a deputafrom from the London, Birmingham, and other School Boards had an opportunity of urging the claims of science, and mentioning the special wishes of the British Association. Nothing could be more distinct than the assurance of both Lord Spencer and Mr. Mundella as to their desire to introduce the teaching of Elementary Science as far as circumstances would permit.

Recommendations somewhat similar to those of the British Association were made, not only by the above School Boards, but also by a Conference of leading educationists on Code Reform, and by the British and Foreign School Society.

When the New Code was laid on the table of the House, on March 6, it appeared that some of these recommendations had been adopted, and that all the clauses in the "Proposals" which were approved by your committee had been retained.

The proposals thus retained are as follows:—

In infant schools the merit grant will be dependent upon the report of the Inspector, who will have to take into consideration the provision made for "simple lessons on objects, and on the phenomena of nature and of common life."

The leading facts of Physical Geography will be taught, not, as before, as an optional specific subject for the high standards, but as a part of Geography which is a class subject for the children in all the standards.

The teaching of the principles of Agriculture as a specific subject is, for the first time, recognised.

The recommendations adopted are as follows:—

"Chemistry" and "Physics" in the two branches of "sound, light, and heat," and of "electricity and magnetism," have been added to the list of sciences capable of being taken up as specific subjects by children in Standards V., VI., and VII.

The scientific specific subjects are admitted for the first time into the curriculum of evening schools.

The Department has considerablv modified its scheme as to "Elementary Science" as a class subject; this "may be framed so as to lead the scholars in Standards I. to IV. up to one of the scientific specific subjects;" but a scheme is also given which "may be taken as a guide suggesting heads for a sufficient number of lessons in each standard." In the scheme, plants are recognised as fully as animals, and the inconsistencies that occurred in the original scheme are avoided.

The Department has not, however, acceded to other recommendations of your Committee. There are still retained such restrictions as will greatly hinder the introduction of this elementary science as a class subject. Domestic Economy has lost its preference as a specific subject in girls' schools. Euclid is still enforced as the handbook of geometry. There is no provision for the examination of pupil teachers by Her Majesty's Inspector in any branch of natural science, excepting that geography is made to include a good deal of physical knowledge.

Your Committee having been informed that Sir John Lubbock intended to move in parliament that it was desirable to allow children to be presented for examination in any ef the recognised class subjects, passed a resolution offering him "their support in asking that the three class subjects of Schedule II. of the New Code, viz., English, Geography, and Elementary Science, should be placed on the same footing." Sir John Lubbock, in his speech, referred to the views of the British Association on this point; the debate which ensued was very favourable to the claims of elementary science, and the Vice President promised to give the subject further consideration, and to "submit it to the Council of Her Majesty's Inspectors and the able men who assisted him in framing the Code, and, if it was possible, he should be happy to yield to the wishes which had been expressed (see *Times*, April 4, 1882).

Many of the Elementary Schools of this country are now working under the New Code, and before the month of May, 1883, they will all be in that condition. In that month also the Government inspection under this Code will commence, and it will be possible to ascertain many points of interest, such as (1) the quality of the object lessons in the infant schools; (2) how far the proposed improvements in the teaching of geography are carried out in practice; (3) to what extent elementary science is taken up as a class subject, and whether the teachers generally take it up as an introduction to the scientific specific subjects, or continue it as a class subject throughout the school; and if so, whether they have adopted some fuller scheme than that suggested in the Second Schedule; (4) whether the discontinuance of the teaching of specific subjects in Standard IV. is really a gain or a loss to science.

Your Committee, if reappointed, propose to obtain information on these points, and to draw the attention of the Council to any matters that may be necessary in connection with the working of the Code, or in respect of any future alterations.

Preliminary Report on the Flora of the Halifax Hard Bed Lower Coal-measures, by Prof. W. C. Williamson, F.R.S., and W. Cash.—The area examined is bounded by Bradford on the north, and Sheffield on the south, many of the coal-pits are now closed owing to low prices of coal, and to the iron-pyrites formerly worked being no longer used owing to the low rate at which foreign sulphur is now imported. Fossils were obtained from a bed of inferior coal 2 feet 6 inches in thickness, studded with "coal-balls," consisting of carbonate of lime and carbonate of magnesia, which are filled with fossils, which exhibit the most perfect condition of preservation, even to microscopical structure, surpassing even the well-known beds of Oldham. Much light has been thrown into the intimate structure of a large amount of vegetable forms, though some are still doubtful.

Tenth Report of the Committee, consisting of Prof. J. Prestwich, Prof. T. McK. Hughes, Prof. W. Boyd Dawkins, Prof. T. G. Bonney, the Rev. H. W. Crosskey, Dr. Deane, and Messrs. C. E. De Rance, D. Mackintosh, R. H. Tiddeman, J. E. Lee, James Plant, W. Pengelly, W. Molyneux, H. G. Fordham, and W. Terrill, appointed for the purpose of recording the position, height above the sea, lithological characters, size, and origin of the Erratic Blocks of England, Wales, and Ireland, reporting other matters of interest connected with the same, and taking measuoes for their preservation. Drawn up by the Rev. H. W. Crosskey, Secretary.—The Committee have received the following accounts of Erratic Blocks examined during the past year:—

Yorkshire.—Major Woodall has examined a number of boulders brought from the bottom of the North Sea north of Flamborough Head, and gives the following account of their position and character:—

North of Flamborough Head large numbers of boulders are found strewing the bottom of the North Sea; but they are arranged very much in a belt, which is generally parallel to the existing coast, at a distance of twenty to forty miles from the land. The outer or eastern edge of this belt is not well defined; but on the western side it would appear to have a sharper boundary, as the marks used by the trawlers to avoid the boulders show that the line is well marked.

While preserving a line parallel to the existing coast, it is curious to note that just opposite to the mouth of the Tees the inner edge of the "rough ground"—by which name this belt is known to the fishermen—makes a sharp bend to the eastward, coinciding almost exactly with a line drawn down the Tees Valley. I would venture to suggest that this large belt of erratic blocks is connected with the history of the giant glacier which descended the Tees Valley, bringing, among other stones, masses of the well-known Shap Fell granite. The boulders that I have seen brought on shore—having been trawled up by the smacks—are either of Shap granite or carboniferous limestone, and of these I have examined from sixty to seventy specimens. The rough ground—as far as I am aware—extends from the coast of Northumberland to the mouth of the Humber. While the boulder clay on the coast line contains blocks of carboniferous limestone and Shap granite, the deposits of like date in the valley of the Rye and Derwent—south of the Cleveland Moor district—are composed of oolitic and liassic detritus, and are very different from those on the coast, though only a few miles distant from each other.

Warwickshire.—A remarkable group of Erratic Boulders has been exposed in some excavations made for building purposes in Icknield Street, Birmingham, between Key Hill and Hockley Hill. The section occurs on the north-west slope of the hill on which it is exposed, and consists of 7 feet or 8 feet of glacial drift (the height slightly varying at different points), which immediately rests on an irregular and broken surface of the new red sandstone of the district, and is composed of about 1 foot 6 inches of surface soil. The "drift" itself consists of erratic blocks, intermixed with numerous round and oval stones and pebbles, together with small gravel, sand and clay. In different parts of the section these various materials occur in varying proportions, a light clay gradually predominating. The erratic blocks, however, so pervade the whole bed, and so thoroughly constitute a component part of it, that they cannot have been dragged into it, either singly or by twos and threes. They must all have travelled together, for a certain distance, at any rate, and have been brought down together to the spot at which they are found.

The felsites and the felspathic ashes are the most abundant, and the Llandovery sandstones are the rarest. No block of granite has been found in this group of erratics.

Some are sub-angular; a not inconsiderable proportion are well smoothed, although they can hardly be said to be highly polished; and on a few striæ may be traced.

Prof. C. Lapworth has examined the specimens, and recognises a large number as occurring *in situ* at the Berwyn Hills; others may be found in the Arenig range.

The condition of the new red sandstone rock on which the boulders rest is most remarkable. The sandstone rock is broken up, and large fragments of it have been lifted up out of their position and thrust into the middle of the drift. At one point in the section a part of the rock has been lifted up almost like an arm, and still remains united with the basement mass, while the drift fills the L-shaped hollow. A large erratic block is seen close to the extreme end of the uplifted arm of the basement.

The evidence of violence is complete. The breaking up of the sandstone rock, the uplifting of parts of it *en masse*, and the carrying away of fragments, are facts as patent as the presence of the erratic blocks themselves.

The Rev. W. Tuckwell has called the attention of the Committee to some very interesting boulders at Stockton, near Rugby, about equi-distant from Leamington, Rugby, and Coventry. One has been moved from the roadside, where it was in great danger of being injured, placed upon a bed of concrete, and protected by railings.

Leicestershire.—Mr. W. Jerome Harrison has sent the Committee the following note on a Leicestershire boulder which has travelled northwards:—

In the construction of the sewerage for the Clarendon Park Estate, near the Victoria Park, on the east side of the town of Leicester, some interesting sections of the drift were laid bare, which I examined in June, 1880. Much of the drift exposed was of a loamy nature, containing erratics of moderately large size, and overlying, though with no well-marked line of demarcation between, the well-known great chalky boulder clay which spreads so widely in this district.

Among the travelled rocks contained in this deposit I particularly noticed one angular block identical in appearance with the syenitic rock which forms Enderby Knoll (four miles south-west of Leicester), and Croft Hill (about two miles further in the same direction). These South Leicestershire syenites are well-characterised and somewhat abnormal rocks, and their identification is easy.

The surface of the Clarendon Park Estate is about 300 feet above sea-level, while Enderby Knoll is about 350 feet, and Croft Hill 450 feet (these heights are approximations only). The block which I saw on the Clarendon Park Estate measured about 3½ × 2 × 1½ feet, and would weigh about three-quarters of a ton; it was irregular in shape and very angular. As it did not interfere with the direct line of the sewer, it was not removed, but was covered in. I have examined a large number of the erratic blocks which stud the surface of Leicestershire, but this is the only instance I know of a boulder which has been carried to a distance several miles due north of its parent rock.[1]

Shropshire.—The Committee have received from Mr. Luff a valuable report upon the group of erratic blocks found in the neighbourhood of Clun, Shropshire.

Prof. Lapworth has examined a series of specimens, and describes them as lower Llandovery grits and shales belonging to the Plinlimmon group of Central Wales. The hills from which they have been derived are all south of Bala, and situated almost due west from their present position.

The following are the most remarkable among a large number of boulders:—The "*Great Boundary Stone*," marking the boundary of Clun and Treverward townships. It is on Rock Hill. Its dimensions are 6 feet × 6 feet × 2·5 feet. No striations can be detected, but it is angular and polished on one face. It is a cleaved flagstone, and has travelled from a point south of Machynlleth. It rests upon a bed of clay and rubble above the Upper Ludlow rock. Height above the sea, 1152 feet.

The "*Black Hill Boulder*," 52° 24′ 40″ N. L., 2° 59′ 50″ W. L. This boulder may be calculated to contain from 8 to 10 cubic feet, and is subangular. It is a pebble grit belonging to the Plinlimmon group, and may have come, according to Prof. Lapworth, from the neighbourhood of Rhadyr. So far as can be observed, it rests upon the same limit of bed as the Great Boundary Stone. Its elevation above the sea is 1327 feet, and it is the highest of all the boulders of the group.

The "10-*Feet Boulder*" is a pebbly grit of the Plinlimmon group. It lies on the Clun Hill, near Pen-y-wern, 52° 24′ 20″ N. L., 3° 0′ 30″ W. L., at an elevation of about 1160 feet above the sea. It measures 10 feet × 3 feet × 3 feet, and weighs, I should calculate, between 6 and 7 tons. It bears every evidence of having stood upright in the ground for a very long time. The base is tolerably angular and well preserved, but the sides and apex are much weathered. About 4 feet from the base it is deeply undercut, apparently all round, exactly as we should expect such a block to be where (on the ground-line) it had been much exposed to the combined influence of moisture and frost.

Report on the Conditions under which Ordinary Sedimentary Materials may be converted into Metamorphic Rocks, by Prof. W. J. Sollas, M.A., describes experiments on quartz and other minerals which have been subjected to a heat of 300° C. in an iron tube of ½ inch diameter.

Report of the Committee for the purpose of carrying on Explorations in Caves in Carboniferous Limestone in the South of Ireland, consisting of the late Prof. A. Leith Adams, Prof. W. Boyd Dawkins, Dr. John Evans, Mr. G. H. Kinahan, and Mr. R. J. Ussher.—Within the past three months attempts have been made to effect an entrance from the face of the scarp into the series of caves discovered and reported on last year, in the rock called the Carrigmurrish, but after a careful survey had been made and levels taken from the several branches of the caves by Mr. Duffin, county surveyor, it was found that this means of access is not possible.

Eighth Report of the Committee, consisting of Prof. E. Hull, the Rev. H. W. Crosskey, Capt. Douglas Galton, Professors G. A. Lebour and J. Prestwich, and Messrs. James Glaisher, E. B. Marten, W. Molyneux, G. H. Morton, W. Pengelly, James Plant, James Parker, I. Roberts, Fox Strangways, Thos. S. Stooke, G. J. Symons, W. Topley, Tylden-Wright, E. Wethered, W. Whitaker, and C. E. De Rance, appointed for the purpose of investigating the Circulation of the Underground Waters in the Permeable Formations of England, and the Quality and Quantity of the Water supplied to various Towns

---

[1] It seems to the writer to show (1) that a submergence followed the retreat northwards of the great chalky boulder clay; (2) that when this submergence amounted to about 350 or 400 feet, the bosses of syenite which occur in South Leicestershire stood as little islands above the sea: (3) that "coast ice" forme on the margins of these islands, on which blocks of rock, detached by the frost, fell: and (4) that a current running northwards carried at least one of these blocks down the Soar Valley, and dropped it where it now lies, on the eastern brow of the Valley at Leicester.

and Districts from these Formations. Drawn up by C. E. De Rance, Secretary.—Eight years have elapsed since this Committee commenced to investigate the circulation of underground waters, and the quantity and character of water supplied to towns and districts so derived.

From 1874 to 1878 the Triassic and Permian formations were alone under consideration; in that year the Jurassic rocks were added to the scope of the inquiry, which at the York meeting was enlarged to include the whole of the permeable rocks in England and Wales.

The Triassic and Permian rocks of Devonshire are described in the first, fifth, and sixth reports; of Somersetshire in the first; of Leicestershire in the first, fourth, and fifth; of Warwick in the second, fourth, and seventh; of Nottingham in the second and sixth; of Cheshire in the second, fourth, and fifth; of Lancashire in the first, second, third, fourth, sixth, and seventh; of Yorkshire in the first, second, third, sixth, and seventh; of Shropshire in the sixth.[1]

Through the removal to South Africa of the member of the Committee taking charge of Staffordshire, this district is still incomplete, but some information as to the Burton-on-Trent area is given in the first report.

In Devonshire the inquiry was carried on by Mr. Pengelly, F.R.S., supplemented by details obtained by Mr. Stooke, C.E. The Triassic rocks of the district have been made the object of careful study by Mr. W. A. E. Ussher. From his investigations it would appear that the sequence exhibited has more in common with the Trias of the French side of the English Channel than with that of the midland counties. In Devonshire and Somersetshire the sandstones and conglomerates appear to have been deposited in a distinct basin to that north of the Mendips, the Keuper marls being alone common to the two districts.

The basin south of the Mendips is remarkable for having a series of marls intercalated in its sandstones, called by Mr. Ussher the "Middle Marls"; these underlie sandstones beneath the Keuper marls. The conglomerates have a distinctly local character, and when present are plentifully water-bearing, as are the sandstones, though to a somewhat less extent.

Private supplies are obtained by wells at Torquay, where the water-level is 168 feet above the sea; at Teignmouth; at Dawlish, where the water-level is 71 feet above the sea; and at Bramford Speke, near Exeter.

Near Exeter the Lyons Holt spring issues at 126 feet above sea-level, yielding towards the town supply 47,000 gallons daily of very pure water, which is extensively used for drinking-fountains.

Higher up the valley of the Exe and its tributaries private supplies are obtained at Crediton.

North is the watershed separating the streams flowing into English and Bristol Channels.

At Wellington a well 230 feet above the sea is sunk to a depth of 48½ feet; only a small quantity of water is pumped from it.

At Taunton numerous private wells give a supply of rather hard water from the New Red Sandstone.

At Somerton hard water is obtained from a well 129½ feet deep; the White Lias is said to occur in it at 90 to 99 feet.

At Wembdon a private well in triassic conglomerate yields hard water at a well 30 feet deep, at 60 feet above the sea.

At Wookey, near Wells, 70 feet above the sea, a private well, 33 feet, yields a constant supply, uninfluenced by the seasons as to quantity, but decreases 9 feet in level after dry weather.

In Bristol the wells vary in depth from 60 to 300 feet, some only penetrating peat and gravel, others passing through triassic marls, whilst a few penetrate the Coal-measures.

At Braysdown Colliery, near Bath, a shaft 500 yards deep, passing through New Red Sandstone and Coal-measures, yielded water at the bottom of the pit containing 1008 grains of common salt, or 1440 parts per 100,000.

In the Tiverton Coal-pit, near Bath, 16,800 gallons per 24 hours are yielded by plastic shale in the Blue Lias, 130 feet above the White Lias, which is 12 feet thick, resting on 23 feet of Rhætics, lying on the New Red Marl; the water contains 112 parts per 100,000 of common salt.

The Tyning Pit, Radstock, intersected a spring yielding 864,000 gallons per day at 200 feet from the surface, at the bottom of the Red Marls.

At Kilmersdon New Coal Shaft, Writhlington, a 10 feet shaft intersected a spring at 253½ feet. On cutting through a hard base of stone the water rose 99 feet in 24 hours, and stands at this level, yielding 98,400 gallons per day of hard water. The section passed through was liassic clay, black and blue marl 78 feet; 34 feet of "red ground," with bands of blue stone; conglomerate 5 feet; red beds 4 feet; then conglomerate again; the remainder of the section is not given. The late Mr. Charles Moore considered the last, 5 feet 4 inches of the Lias, in this section to belong to the Rhætic beds.

In reference to the information furnished by Mr. Taunton as to the Thames and Severn Canal, it may be well to state that the outcrop of the oolitic rocks has an average breadth on the dip of 25 miles. The base of the Oolites resting on the Lias reaches its highest point near Chipping Campden, 1032 feet above the sea, on the watershed between the Thames and Severn basins. This, south of the Severn Wells, the source of the Churn, runs somewhat east of the base of the Oolite, causing the surface drainage of the oolitic tract around Minchinhampton, Dursley, and Wotton-under-Edge to flow into the basin of the Severn. It is probable also that a portion of the underground drainage does so also, notwithstanding the general south-easterly dip, from the basement level of the Oolites, varying in the direction of the strike, owing to the denudation of the escarpment being unequal, the Oolite to the south having been worn back much further down the dip, and consequently to a lower elevation than at Chipping Campden, descending from 1030 at the latter place, to 212 feet in the Stroud Valley, or about 800 feet in 25 miles. South of this valley the level rises slightly, so that a partial discharge of underground drainage takes place in this valley, which is immediately west of the point in the Thames and Severn watershed which is penetrated by the canal connecting the two basins.

Of the 25 miles of average outcrop of oolitic rocks measured on the dip, only about 8 consist of impermeable deposits:—viz. the Fuller's Earth, the Oxford Clay, and the Kimmeridge Clay—so that two-thirds of the area may be considered to be of a permeable character.

Warwickshire information.—The southern and western portion of the Warwickshire coalfield is overlaid by Permian rocks consisting of reddish-brown and purple sandstones, intercalated with marls in lenticular beds, rising to a height of 622 feet at Cowley Hall, which forms part of the watershed between the tributaries of the Trent to the North, and those of the Avon on the south.

Though the surface-drainage of this Permian area flows in opposite directions, that portion of the rainfall percolating into the ground has a uniform gradient to the south, the base of the Permians, where they rest on the coal-measures west of Atherstone, being 470 feet above the sea, and 170 feet under the Mithurst Tunnel of the Midland Railway, being a fall of 50 feet per mile, while at Warwick the tops of the Permians are 186 feet above the sea, and as they are not less than 800 feet thick, their base is probably about 600 feet below the sea-level, giving a furtherr fall of 786 feet in 18 miles, or a fall of 43 miles.

Examining the district more minutely, it is seen that though the Permians do not always lie conformably on the coal-measures, yet there is a general conformity, and a synclinal flexure traversing the coal-measures from north to south is shared by the overlying Permians, which have synclinal dips towards the axis of an average amount of 3°, or about 270 feet per mile from the edges of the basin towards the axis, which occurs more to the eastern than the western margin.

The fault throwing in the coal measures of Arley Wood is believed to be connected with the fault throwing back the outcrop of the main part of the coal-field at Broomfield Park; but of this there is no evidence, and as the dips in the Permian show the flexures to be present on both sides of the supposed fault, its existence is very doubtful. If it occurred, and were a water-tight barrier, the water percolating into the sandstones to the west of Atherstone and flowing south would be thrown out in a line of springs, which is not the case; and there is no doubt that the waters travelling in the porous portion of the system flow south to Leamington and Warwick, where a portion of the supply is utilised. South of this point the Permians are concealed by triassic, liassic, and oolitic rocks in the direction of Bambury. Southwards the Permians probably wedge out before the Trias, which continue into the Thames basin, the water travelling down the dip planes of the Permian, where that formation thins out, probably enters the overlying triassic sands,

---

[1] Report of British Association for 1875 (Bristol) contains first report; that for 1876 (Glasgow) the second; that for 1877 (Plymouth) the third; that for 1878 (Dublin) the fourth; that for 1879 (Sheffield) the fifth; that for 1880 (Swansea) the sixth; and that for 1881 (York) the seventh.

and, prevented from rising higher by the Keuper marls, probably flows a considerable distance under the Thames basin, where its outlet being checked by the thinning out of the Lower Trias against the Palæozoic ridge, causes the subterranean Trias to be fully charged with water in a stationary condition, and thus limits the amounts of absorption in the area of absorption.

Between the base of the Permian and the *Spirorbis limestone* is a thickness of 150 feet, and between it and the first workable coal is a further 500 feet, of which a large portion consists of Permian sandstone fully charged with water, which was met with in sinking the Exhall Colliery.

The report also contains:—Appendix I.—Millstone Grit Wells. Appendix II.—Permian and Trias Wells, chiefly collected by Mr. E. B. Marten, C.E., Mr. S. Stooke, C.E., and Mr. H. T. Marten, C.E.. Appendix III.—Jurassic Wells.

Appendix IV., by Mr. E. Wethered, F.G.S., is on the porosity and density of rocks, and gives the results of a very elaborate investigation into the size of the grains, in decimals of an inch, making up the permeable rocks of England and Wales, of various geological ages, the specific gravity of these rocks, the specific gravity of the particles, the volume of water absorbed by 100 volumes of rock, the number of gallons of water absorbed per cubic foot of rock, and the number of gallons of water absorbed per square mile of rock three feet thick, and the relation of these volumes to the purity of the water obtained.

First Report of the Committee, consisting of Prof. Flower, Dr. Beddoe, Mr. Brabrook, Mr. F. Galton, Mr. J. Park Harrison (Secretary), Dr. Muirhead, General Pitt-Rivers, Mr. F. W. Rudler, and Mr. Charles Roberts, appointed for the purpose of obtaining Photographs of the Typical Races in the British Isles.—Owing to the accumulation of observations of height, weight, and other physical characteristics of the inhabitants of the British Isles, the discussion of which required the undivided attention of the Anthropometric Committee, the acquisition of photographs undertaken by them in 1876 was last year transferred to a Committee of the Anthropological Department.

The photographic portraits already collected have been handed over to the new Committee, and will assist materially in determining the values of crosses in different parts of the country. Some, obtained under exceptionally favourable circumstances, and especially seventeen portraits of Shetland Islanders, well illustrating the Scandinavian element in the population, and presented by Dr. Muirhead, may be safely termed typical.

The Scientific Bearing of the Subject.—A clear definition of racial features, illustrated by examples, will, the Committee believe, prove of considerable importance in connection with more than one social question.

1. First, as tending to allay national animosities springing from a belief in the preponderance of some one race, and, in connection with this, affording a safe basis for generalisation, in the place of deductions depending on doubtful traditions and insufficient historical data.

2. A correct description of the main racial types would also afford an opportunity of testing in a more complete manner than is now practicable the truth of views, believed to be extensively held, on the subject of racial tendencies and proclivities

3. Indirectly, by indicating the way in which features, and more especially profiles, of human beings should be observed, it would lead to a more exact description of criminals and deserters, resulting, it cannot be doubted, in more frequent arrests. At present, so little attention is paid to the subject that photographs of prisoners are taken solely in full face, and the description of recruits for the military rolls is confined, so far as their features are concerned, to the colour of the hair and eyes.

Erroneous Views regarding the Possibility of a Survival of Racial Features at the Present Day.—Before proceeding further, the Committee think it will be well to notice an objection, not infrequently made, that European populations are now too much mixed to allow of racial types being recognised. This is not the belief of anthropologists generally. Prof. Rolleston—whose loss this Committee has especial reason to deplore—expressed no uncertain opinion on the subject in his address to the Anthropological Department at Bristol. "At once, upon the first inspection of a series of crania, or, indeed, of heads, from such a (mixed) race," he said it was evident that "some were referable to one, some to another, of one, two, or three typical forms;" also that intercrossing has left the originally distinct forms still in something like their original independence, "and in the possession of an overwhelming numerical representation;" and Prof. His was quoted as having arrived at a similar conclusion from an investigation of the ethnology of Switzerland (Brit. Assoc. Rep., 1875, p. 148).

Prof. Kollmann, too, of Bale, believes that it is quite possible to distinguish original or main racial characteristics in a mixed population, owing to a capacity in skulls and facial skeletons to preserve their pristine types long after the colour of the hair and eyes have changed by crossing. A complete fusion of component elements, the distinguished Professor is convinced, never absolutely occurs.

Reversion to Original Types.—Besides, however, these composite forms, eminent anthropologists admit a natural law, through the operation of which a complete reversion takes place, under favourable circumstances, to original types. Drs. Beddoe, Barnard Davis, Flower, Rolleston, Thurnam, and Turner, in this country, and Morton, Broca, Quatrefages, Retzius, and Virchow, abroad, have satisfied themselves, from craniological evidence, that prehistoric characteristics exist at the present day; Prof. Quatrefages, than whom the Committee believe there could not be a safer authority, even affirming that representatives of the fossil types of man are still to be found amongst us ("Crania Ethnica," p. 28).

Height and Colour of the Hair and Eyes insufficient as Evidence of Race.—Assuming the correctness of Prof. Kollmann's deductions that hair and eyes (permanent in a pure race) change by crossing more easily than skull forms; dark tints, except under conditions of intensity, joined with diminutive stature and complete dolichocephalism, such as unmistakably point to the race styled Iberian, simply indicate, according to the index of nigrescence established by Dr. Beddoe, more or less mixture in blood. Where, however, hair and eyes are light, and the stature tall, in the absence of information respecting the features generally, it would be impossible to pronounce any individual to be Celt or Saxon, Dane or Swede.

Birth of Parents and Grandparents in the same Locality no Proof of Race.—An experiment made for the purpose of ascertaining how far the birth of parents and the grandparents, on both sides, in certain districts would assist in the selection of pure local types, resulted in the conclusion that the requirement mentioned, though securing the absence, of recent foreign admixture, failed as a sufficient test, by affording no evidence that movements had not occurred in the population at an earlier date.

Photographic portraits obtained under the above-mentioned conditions do not, as a fact, assist materially in the definition of racial characteristics; the features exhibit more than one type even in districts supposed to have been peopled by a given race; though, owing to the law already alluded to, pure types may be sought for, and would more frequently be found amongst such populations than elsewhere.

This, and other considerations, led a sub-Committee, in 1880, to collect in preference, from different localities, a certain number of portraits, all of which exhibited similar features; and then an equal number distinguished by characteristics in all respects different from the first series, but equally homogeneous. They presented contrasts which appeared to be racial.

Method of Identification of Types adopted by the Committee.—Approaching the subject from the standpoint of comparative physiognomy alluded to in the last paragraph, but experimenting in the first instance on the facial skeletons of skulls obtained from ancient tumuli and cemeteries in different parts of the British Isles, it was found on superimposing tracings of the skeleton profiles of the three main types figured in the "Crania Britannica," that the brows of the Brachycephalic, round-barrow types were more prominent, and the nasal bones more angular and sharply projecting, than those of the Dolichocephalic, long-barrow type; whilst brows and nasals in the Teutonic skulls (and especially those of the Saxons proper) were respectively smooth and little prominent. The main characteristics in the profiles of the Round-barrow man and the Teuton would clearly have been the high-bridge of the nose of the former, and the entire absence of an arched nose in the Saxon.

Similar results were obtained from measurements of skulls in the Anatomical Museum at Cambridge, purchased from Dr. Thurnam by Prof. Humphry, and presented by him to that University. Also some skulls in the Museum of the Royal College of Surgeons, and the Greenwell collection at Oxford, have been measured and found to exhibit the same contrasts. Mr. Harrison, who obtained the measurements for the information of the Committee, found that the mean difference in projection of the nasal bones in skulls from the round-barrows, as measured from the basion to fixed points on the dorsum and the nasion, or root of the nasal bones, is about twice that observed in purely Teutonic crania. In the fine collection of true Saxon skulls from Wiltshire, obtained by General Pitt-Rivers, the principal characteristics are a rounded forehead and smooth brow, and but little projection in the nasals; and this in the male as well as the female skulls.

The points of contrast in the skeleton features of the two races were noticed by Dr. B. Davis; but owing to Saxons and Angles being at the time he wrote considered equally Teutonic, the differences observed in some of the examples selected by him to illustrate types, are not so strongly marked as in others. Dr. Beddoe and Mr. David Mackintosh, it should be mentioned, both consider the Anglian features to have been more prominent than the Saxon.—When proceeding to define tribal differences and crosses, the nasal forms will, with other features, be subjected by the Committee to more minute examination.[1]

The above facts having been sufficiently ascertained, it was easy to compare the skeleton features of the two main types—viz., the Round-barrow man and the Saxon—with profiles of living subjects in this and neighbouring countries presumably inhabited by similar populations. Whenever the osseous and other features were found to correspond, at the same time that they differed entirely from other equally well-marked types, it was assumed that the characteristics belonged to distinct races.

In the following definitions the main types are designated by capital letters, intended to be used as symbols when dicussing racial crosses:—

The First or Dolichocephalic Dark Type, A.—The definition of the short, narrow-headed race shown by Dr. Thurnam and Prof. B. Dawkins to have preceded the so-called Celts, and termed by them Iberian (=the Silurian of Prof. Rolleston), is at present incomplete. The forehead, however, appears to have been fairly vertical, the brows prominent, the nasal bones long and straight, the lower jaw weak (Rolleston), and the hair and eyes dark. Statistics of the colour of the hair and eyes, collected by Dr. Beddoe, show that the race exerted a much wider influence on the population than is usually supposed. A number of photographs, which, it is believed, represent varieties of the type, have been placed on cards.

The Second or Brachicephalic Fair Type, B.—The principal characteristics of this race consist in the prominence of brow and supra-nasal ridges; a slightly receding forehead; sharply projecting nasal bones, causing a high-bridged or arched nose, without undulation; a long, oval face: high cheek-bones; and a prominent fine chin. From Mr. Park Harrison's observations the lips of this type appear to be thin, and the ear pear-shaped, with no proper lobe, the fossa being continuous.

The above features are found associated with light hair and eyes, and a stature above the average.

This type includes Belgic, Cymric, and Danish varieties, which, further observation, the Committee believe, will by-and-bye enable them to differentiate; as also the Anglian, Jutish, and Frisian types. They have selected several portraits, which present common characteristics.

The definition of Type B agrees in all the main points with descriptions given some years ago by Dr. Beddoe, Mr. David Mackintosh, and Mr. Hector Maclean, as well as with Dr. Rolleston's deductions in the appendix to "British Barrows."

The Third or Sub-Dolichocephalic Fair Type, C.—The Committee believe that the following is a correct definition of true Saxon features. Brows smooth; forehead rounded and vertical; nasal bones short and straight; nose not arched, ending in more or less of a bulb; face elliptical, rounded; cheek-bones broad; chin rounded; lower part of face wide; eyes prominent, in colour blue or bluish grey; lips moulded; ears flat, with formed lobes; face and frame well covered. Height about the average.

The definition accords with Schadow's pure German (Teutonic) type, and with the Saxon type of Beddoe and Mackintosh.

Photographs conforming in all respects to the above characteristics have been obtained from Sussex and several other English counties; and from Scotland, Sweden,[2] Germany, and France. Specimens have been arranged upon cards.

No photographs have as yet been taken specially to illustrate the three types, the Committee thinking it best to proceed before doing so with the definitions of racial varieties.

New Designation of the Committee.—If re-appointed, they suggest that it should be "for the purpose of defining the facial characteristics of the races and principal crosses in the British Isles, and obtaining illustrative photographs with a view to their publication."

Constitution of the Committee.—Prof. Flower having been unable to take an active part in the proceedings of the Committee owing to pressure of other work, and having expressed a wish that another chairman should be appointed, they hope that General Pitt-Rivers will undertake the duties.

Photographs.—Mr. Barraud, who was asked to act as an Associate, has presented some cabinet photographs of well-known persons for exhibition. The Committee have also received from Dr. Beddoe a portrait in full face and profile, taken at his expense, of a native of Montgomeryshire. It is a good example of the Silurian type. Other photographs have been received in illustration of Types B and C.

The Committee ask for a renewal of the grant of 10*l.*, with an addition sufficient to procure the requisite negatives, and also photographs from different counties to illustrate crossing.

Report of the Committee, consisting of Dr. M. Foster, Dr. Pye-Smith, Prof. Huxley, Dr. Carpenter, Dr. Gwyn Jeffreys, the late Prof. F. M. Balfour, the late Sir C. Wyville Thomson, Prof. Ray Lankester, Prof. Allman, and Mr. Percy Sladen (Secretary), appointed for the purpose of aiding in the maintenance of the Scottish Zoological Station.—The Committee beg to report that, with the aid of the sum of 40*l.* voted last year, further investigations have been made by Mr. Romanes, F.R.S., and Prof. Cossar Ewart on the "Locomotor System of the Echinodermata." The work of the station was carried on at Oban, where, in addition to the ordinary forms abundant on the east coast, *Antedon* was plentifully obtained for examination. The investigators directed their attention—1. To completing their observations on (*a*) the internal nervous system of *Echinus;* (*b*) the external nervous system of *Asterias;* and (*c*) the nature of the nervous system of *Antedon.* 2. To the effects of rotation on inverted echini. 3. To the effects of poisons on echini and other invertebrates. 4. To the natural movements of *Antedon*, and to the influence on these movements of partial destruction of the nervous system. The publication of the results obtained at Oban is reserved until the further researches now in progress are completed this year. It may be added that a fine specimen of the rare compound Ascidian, *Diazona violacea*, was dredged in the Sound of Mull. During the present autumn Mr. Romanes and Professors Ewart and Schäfer are at work on the Ross-shire coast. The Committee again beg respectfully to request that a sum of 50*l.* be voted to assist in meeting the expenses of the station.

Report on the Progress of the International Geological Map of Europe, by W. Topley, F.G.S.—A committee was appointed by the Geological Congress of Bologna to prepare a map of Europe. An account of the proceedings of this Congress has already appeared in NATURE. The present Report deals chiefly with the progress since made. Arrangements have been made with Reimer and Co. of Berlin, for the engraving and publication of the map. MM. Beyrich and Hanchecorne are the directors for the map. The topography of the British Isles is already engraved; a proof was exhibited to the meeting.

Report on the Earthquake Phenomena of Japan, by Prof. J. Milne, F.G.S.—This paper was illustrated by diagrams showing the effect of earthquake waves at the Palazzo Palmieri, Polla, in the Neapolitan earthquake, and in the earthquake traversing Tokio Bay on February 22, 1880, in which the centres of origin of the waves are indicated, in another the manner of interference of earthquake waves, in the ground underlying Yokohama. Earthquakes of the north-east of Japan do not spread south-west, owing to the tract of high ridges lying in their path, which form a barrier to their movement, while to the south-east, east of the central mountain axis, there is a flat district, which invariably receives the shocks. The author is preparing a seismological atlas, which shows the large number of seismic centres in which the earthquakes originate, and the relative intensity of the waves and the areas affected. Outside the island occur several seismic centres in the open sea. The waves propelled from these centres breaking against the mass of the mountain, are either reflected or absorbed by the mass. In regard to the velocity of earth-

---

[1] Prof Flower, speaking of the racial value of the nasal bone, when describing the cranial characters of the natives of the Fiji Islands, says: "The nose is one of the most important of the features as a characteristic of race, and its form is very accurately indicated by its bony framework" (*Jour. Anthrop. Inst.*, vol x. p. 160) Dr. Broca defines six forms.

[2] The Dolichocephalic Swedish race of Retzius was believed by him to be closely allied to the Saxon.

quake waves, the author described the "time-take," which is a clock which is an automatic arrangement causing dots to be made and the time of wave-motion to be indicated without stopping the clock. He describes shocks observed by him in Japan as travelling at 10,000 feet per second, decreasing as it went on to 4500 feet, getting slower and slower as it went on. The waves last from thirty seconds to four minutes. The author describes the result of experiments carried out by himself and Mr. Gray as to artificial earthquakes, explosions of 2 lbs. to 5 lbs. of dynamite in bore-holes 10 feet in depth, fired by electricity, and the effect of letting a heavy iron ball fall on the ground to a depth of 20 to 30 feet in height. The effect of shocks is communicated along the surface, gradually decreasing as it proceeded from the point of propagation, but at a less rate as the distance increases.

SECTION A—MATHEMATICAL AND PHYSICAL

On the Absolute Measurement of Electric Currents, by Prof. Lord Rayleigh.—The absolute measurement of current is more difficult than that of resistance. All the methods hitherto employed require either accurate measurements of the horizontal intensity of the earth's magnetism or of coils of small radius and many turns. This latter is difficult to evaluate, as it is impossible to measure the length of the wire wound, as the tension necessary to make the wire lie evenly, stretches it very considerably, whilst it is most important to determine the mean radius accurately, as an error therein doubles itself in the final result. The method of Kohlrausch is free from this objection, but it requires a knowledge of the moment of inertia, a quantity not easy accurately to determine. When the electromagnetic action is a simple force, it can be determined directly. In Mascart's recent determination, a large solenoid is suspended vertically in a balance, and is acted on by a flat co-axal coil of much larger radius. This is simple to think about, but not calculated to secure precise results. The appearance of accuracy is illusory, unless it can be assumed that the distribution of wire is absolutely uniform. It would appear that all the turns of the suspended coil should operate as much as possible, that is, that the suspended coil should be compact, and should be placed in the position of maximum effect. There is a further incidental advantage in this arrangement. The expression for the attraction involves as factors the product of the number of turns, the square of the current, and a function of the mean radii of the two coils, and of the distance between their mean planes. This function is of no dimensions. When the position is such that the function for two given coils is a maximum, the result is practically dependent only on the two mean radii, and the function being of no dimensions, can involve these mean radii only in the form of a ratio. This can be obtained electrically with full precision by dividing a current between them in such a way that no effect is produced on a small magnet at their common centre. In practice it will be desirable to duplicate the fixed coil, placing the suspended coil midway between two similar fixed ones, through which the current passes in opposite directions.

On the Duration of Free Electric Currents in a Conducting Cylinder, by Lord Rayleigh.—This paper was devoted to considering the rate of decay of currents of electricity circulating round a conducting cylinder. The time in which the intensity sinks from e to 1 is called the "time of subsidence." For a copper cylinder of r centimetres radius, this is equal to $r^2/800$. That this may be one second, the diameter of the cylinder must be two feet.

On the Equilibrium of Liquid-conducting Surfaces charged with Electricity, by Lord Rayleigh.—This was a mathematical paper in which was investigated the condition of stability of a sphere of fluid charged with electricity. If Q be the charge, T the surface tension of the fluid, and a the radius of the sphere, then the condition of stability is that $T > Q^2/16\pi a^3$.

Preliminary Account of Results obtained during the late Total Solar Eclipse, by Prof. Schuster and Capt. Abney.—Three photographs of the corona were obtained with different exposures. The comet Tewfik, discovered during the eclipse, appears on the photographs, and the change of its position in successive plates shows that it was moving away from the sun. The corona is seen to extend over a solar diameter away from the sun. A plate exposed in a camera which had a prism in front of the lens shows the spectra of different prominences, which are not found to be identical, but in every case the lines H and K are the strongest. A photograph obtained in a complete spectroscope shows (1) a complicated prominence spectrum; (2) a strong continuous spectrum in the lower parts of the corona; (3) a reversal of the solar line G in the upper regions; (4) a series of coronal lines, different from the prominence lines.

Some Matters relating to the Sun, by Prof. Schuster.—Observations of the shape assumed by the solar corona in successive eclipses during the last fifteen years have shown remarkable changes coincident with the sun-spot period. The corona of sun-spot minimum is characterised by a certain symmetry about an axis not far removed from the sun's axis of rotation, but very likely not quite coincident either with it or with the perpendicular to the ecliptic plane. Some apparent irregularities in the symmetry seem to be due to differences in the position of the earth in its annual orbit. Changes in the spectroscopic and polariscopic properties of the corona which are coincident and connected with the changes of form seem to point to partly meteoric origin of the corona.

On a Misprint in the Tidal Report for 1872, by Mr. G. H. Darwin.—Mr. Darwin has recently been carrying out a laborious reduction, by the Method of Least Squares, of the observations of the tides of long period at a number of stations. The results, which seem to have an important bearing on the question of the rigidity of the earth's mass, will appear as § 848 in the new edition of Thomson and Tait's Natural Philosophy, now in the press. Subsequently to the completion of the calculations, Prof. J. C. Adams discovered a misprint in the Tidal Report of 1872, which forms the basis for the method of harmonic analysis, which has been applied to the tidal observations. On inquiry of Mr. Roberts, who has superintended the original computations, Prof. Adams learnt that the erroneous formula has been used in all the reductions of the long period tides. The erroneous formula occurs near the middle of p. 471 of the Report of the British Association for 1872, in the instructions for clearing the diurnal means from the undue influence of the short period tides; in the first of the two formulæ for that purpose, the factor sin 12 n/sin $\frac{1}{2}$ n should obviously be replaced by sin 24 n/sin n. The tides of long period are evaluated by the following process:—A mean is taken of the twenty-four heights of the water above the datum line at each mean solar bour during the twenty-four bours. The 365 diurnal means form the results of tidal observation for the whole year, and these are to be treated by harmonic analysis; but the continuous integrals which arise in Fourier's method are of course replaced by finite integrals. This method of procedure introduces an undue influence of the short period tides on the values deduced for the long tides, and a correction to each diurnal mean is necessary to get rid of this influence. It is in the formula for the correction to be applied in the case of the semi-diurnal tides that the error occurs. This paper is an evaluation of the maximum effect which can have been exercised on the results by the error. The analysis shows that all the values assigned to the long period tides in the Tidal Reports and Tide Tables must have been more or less vitiated. The lunar fortnightly declinational tide, the semi-annual and the annual tide have suffered comparatively little. The monthly elliptic tide has suffered more, and the synodic fortnightly tide will in many years have been utterly worthless. The paper contains suggestions of a new method of procedure in the harmonic analysis of the tides of long period, and also discusses a remarkable result of the procedure by diurnal means in consequence of which there is an exaggeration of the undue influence exercised by the short-period tides on those of long period, in which either the sum or difference of the speeds is exactly 15° or 30° per mean solar hour.

On the Velocity of White and Coloured Light, by Mr. G. Forbes.—The author gave an account of experiments made by him in conjunction with Dr. James Young, F.R.S., with a view to determining the velocity of light. This research has been published in the *Transactions* of the Royal Society. The chief point of interest is that it appears that the velocity of blue light is greater than that of red, the difference being between 1 and 2 per cent. of the whole velocity.

Lord Rayleigh could give no other possible explanation of the phenomena described by Mr. Forbes, but he had great hesitation in accepting them from considerations on other sides. Michelson altogether repudiated them, and Lord Rayleigh thought that Foucault's method, that used by Michelson, was better suited to bring out results, if such existed, than Fizeau's, for it would produce a spectrum of considerable length. He would refer to some other points which he noticed in a letter to NATURE about twelve months ago, especially as to what is meant by the velocity of propagation of a wave. In a regular train of waves this was the velocity with which any given phase of a wave moved forward; this could easily be observed in the case of waves on water, but in the case of light no wave form could be observed. The velocity determined by Fizeau's method, or by the eclipses of Jupiter's satellites, was not this, but the velocity of propagation of intermissions of light, which if the true velocity of propagation is a function of the wave-length, is not the same as the true velocity; it is only the same where, as in the case of air, the velocity of propagation is the same for all wave-lengths. Foucault's method (Michelson's) is based on determining the angular motion of a mirror between successive reflections, which again is a different quantity from the former two.

Sir W. Thomson wished to testify that the experiments were made most carefully, and felt unable to suggest any other explanation than Mr. Forbes's, but he felt strong previous objections to accepting it. He pointed out that Mr. Forbes's observations made the velocity of propagation smaller for waves of shorter period, whilst from the analogy of sound in elastic bodies we should expect the opposite.

SECTION B—CHEMICAL SCIENCE

On the Reversals of the Spectral Lines of Metals. By Professors Liveing, M.A., F.R.S., and J. Dewar, M.A., F.R.S.—The authors have a twofold object in view in the study of this subject, (1) to trace the parallel between the condition of the elements as they exist in the sun and those in which they may be placed on the earth; (2), that a knowledge of the reversible lines might aid to distinguish those due directly to the vibrations of the molecules and those produced by superposition of waves or by some strain upon the molecules, such as the electric arc might produce. They classify the reversals, as follows; (1) Reversals produced when the expanded line itself forms the background against which the absorption line is narrowed because the density is less than that of the emitted vapours. These are the ones most generally known. (2) Reversals in which there is little or no expansion of the lines, the background being either the hot walls and end of the tube, the hot pole of the arc, or such part of the spectrum which is so full of lines as to be nearly continuous. Photographs exhibiting the reversals of the lines of iron and other metals, were shown. (3) Reversals in which the background is produced by the expansion of a line of some other metal. Photographs were shown in which the lines of iron and other metals were seen reversed on the expanded lines of magnesium. (4) Reversals produced by the introduction into the crucible in which the arc was of a gentle current of hydrogen, coal gas or ammonia, by which means the metallic lines were almost swept away and the continuous spectrum increased. (5) When a carbon tube passed through a perforation in a block of lime is made the positive electrode of the arc, and a carbon rod passed into another perforation so as to meet the tube in the centre of the block, be made the negative electrode, the tube becomes gradually heated up, and in the direct line of the tube the lines are seen bright, because there is no background, but are seen reversed against the hot walls of the tube. Further the effects of the gradual increasing temperature were traced, as the tube was gradually heated. (6) A double reversal of lines is occasionally observed, and an instance was shown, in which the expansion of the magnesium lines between K and H, had taken place to such an extent as to produce the reversal of the most refrangible of the cyanogen bands; the magnesium producing a broad absorption band against which the magnesium triplet stood out bright and sharp. It is probable that this arises from the less dense but intensely heated magnesium vapour being pushed forward up the tube by the sudden burst of vapour produced when a fresh piece of metal is dropped into the arc.

On the Legal Flashing Test for Petroleum, by F. A. Abel, C.B., F.R.S.—The defects of the old legal flashing test, called the open test, and the test used in the United States, known as the fire test, led to the introduction of the close-flashing test, which was legalised by Act of Parliament in 1879. The author exhibited the apparatus required, and described the method of using this test. This test has since been adopted in Germany and the United States, and the investigations conducted in the former country by Dr. Foerster and others, showed what had already been observed by the author, that the results obtained with the apparatus were influenced by atmospheric pressure. The most recent investigations of the author and Mr. B. Redwood, have shown that a variation in the height of the barometer of one inch, was sufficient to produce a change of two degrees Fahrenheit in the flashing point of one and the same sample of oil. Further, it appears that the changes of atmospheric temperature have some influence on the flashing point of a sample of oil, and not only is it necessary to cool down the sample of oil immediately before testing it, when its temperature exceeds 65° F., but it is imperative, in cases where the oil has been stored in localities, the temperature of which is above 65° F., to maintain the oil at a low temperature for a considerable period before testing it. In consequence of this effect of changes of atmospheric temperature, some difficulties have arisen in applying this test in India, and investigations are at present being conducted, the object of which is to ascertain the conditions required for securing the attainment of trustworthy results by the application of this test in tropical climates.

On the Boiling Points and Vapour Tensions of Mercury, of Sulphur, and of some Compounds of Carbon, determined by means of the Hydrogen Thermometer, by Professor J. M. Crafts.—A description was given of the hydrogen thermometer used, the replacement of air by hydrogen was adopted because of the more rapid flow of hydrogen through a capillary tube, further, the bulb of the thermometer could be reduced from 200-500 cc. to 1-10 cc. The thermometer was one of constant volume in which an electric contact between the mercury in the manometer and a platinum point causes a current to excite a magnet and close a cock to arrest the flow of mercury into the manometer tube at the moment the gas attains a fixed volume, as determined by the surface of the mercury touching the platinum point. The boiling point of mercury has been redetermined, and found to be 357° (at the normal pressure), that of sulphur was found to be one degree lower than that assigned to it by Regnault. Naphthalene b. p. 218·08 (bar. 760 mm.), and benzophenone, b. p. 306°·1 C. (bar. 760 mm.), were also used to obtain constant temperatures near 200° and 300°. The boiling points of these two substances were determined under reduced pressures varying from 87 to 2,300 mm., giving a series of temperatures that can be easily established and maintained for any length of time, and ranging from 140° to 350°. It is probable that benzene may be easily obtained sufficiently pure to be used in a similar manner. A series of determinations of the boiling points of several carbon compounds have been made, from which it appears that successive, similar additions to the molecular weight do not cause the boiling points to rise by a constant quantity as supposed by Kopp, but that in a large number of cases the increments to the boiling temperatures diminish by a constant quantity.

The Velocity of Explosion of a Mixture of Carbonic Oxide and Oxygen, with varying quantities of Aqueous Vapour, By H. B. Dixon, M.A.—The author has compared the velocities of explosion of mixtures of carbonic oxide and oxygen with varying quantities of aqueous vapour, by observing the pressure registered in a mercurial gauge attached to the endiometer in which the gases were fired. In each experiment the same mass of carbonic oxide and oxygen was exploded at nearly constant volume and temperature. The gauge was U shaped and contained air in the closed limb. An index similar to that used in Six's thermometer was carried up and left at the highest point reached by the mercury. Near the bend of the guage two bulbs were blown to act as reservoirs, enabling the mercury to be lowered in the endiometer, without allowing air to escape from the closed limb. The endiometer was dried at 80° by drawing through it, for half an hour, air which had passed through tubes containing sulphuric acid, and a tube containing phosphoric pentoxide. It was found that in this way just sufficient aqueous vapour remained in the tube to enable the explosion to take place slowly when the sparks from a Rhumkorff coil was passed through the mixed gases. In the first experiments several sparks were passed before the gases took fire. Experiments were made in which measured quantities of aqueous vapour were added, and the vapour kept below saturation, and also with the gases saturated with moisture. The results obtained in these experiments show the pressure registered to increase with the amount of moisture present in the gases, and to be the greatest when the gases are saturated.

On the Activity of Oxygen, and the mode of formation of Hydrogen Dioxide, by C. T. Kingzett, F.I.C., F.C.S.—An account is given of the various views held regarding the formation of ozone and hydrogen peroxide by slow oxidation, in the formation of the latter by the slow oxidation of the terpenes, the author considers that an organic peroxide is first formed, from which by contact with water hydrogen peroxide is produced as a secondary product. The views of Traube (*Chem. Soc. Journ.* 1882, 795) are criticised. The author prefers to represent peroxide of hydrogen as oxygenated water, thus, OOH_2, rather than hydrogen dioxide, a representation which is considered to explain its properties and reactions more adequately.

Metallic Compounds containing Bivalent Hydrocarbon Radicals, Part III., by Professor I, Sakurai, F.C.S., Tokio University, Japan.—By acting on monomercuric methylene iodide $Hg(CH_2)I_2$ (described in the Report of 1880) with mercuric chloride, monomercuric methylene chloriodide $HgCII_2ClI$ is obtained. This compound is acted upon by iodine, and yields mercuric iodide and methylene chloriodide CH_2ICl, which is a liquid boiling at 109° and having a specific gravity of 2·49 at 20°. The formation of this latter substance shows that monomercuric methylene chloriodide has the following constitution, $ClCH_2HgI$. Attention is drawn to the fact that the boiling point of the methylene chloriodide is approximately the mean of the boiling points of methylene chloride and iodide.

Hydrocarbons of the Formula $(C_5H_8)_n$, by Prof. W. A. Tilden, F.R.S.—An account was given of the existing knowledge of isoprene, and the author finds that it forms a tetrabromide $C_5H_8Br_4$, a liquid which cannot be distilled without decomposition. When oxidised by nitric acid isoprene yields oxalic acid, but form and acetic acids are produced when chromic acid is employed. Since isoprene can be converted into caoutchouc, experiments have been made to ascertain whether this hydrocarbon could be obtained from other sources, and inasmuch as isoprene can be converted into a true turpentine, this latter substance was studied with this object. The author found that when turpentine is passed through a red-hot tube a mixture of hydrocarbons is obtained, from which a small quantity of a volatile liquid, having the composition and properties of isoprene, has been isolated. The formulæ assignable to the eight possible compounds having the composition of C_5H_8 was discussed, as also was their relation to the terpenes.

The Ærorthometer, an Instrument for Correcting the Measure of a Gas, by A. Vernon Harcourt, M.A., F.R.S.—The object of this instrument is to simplify the method of reducing the volume of a gas to normal conditions of temperature and pressure. The instrument consists of two narrow tubes, the one open above, the other terminating in a bulb, whose capacity, including that of the stem down to the first graduation, is 1000 of the units with which the stem is divided; both tubes are connected below with a reservoir from which mercury can be driven up the tubes by the pressure of a screw. When the mercury stands at the same level in the two tubes, the air in the closed tube, which at 0° and 760 mm. occupies 1000 volumes is under existing atmospheric pressure. It has also the temperature of the surrounding air, and is therefore under the same conditions as the gas in any vessel near it. The volume read on the ærorthometer is to 1000 as the observed volume of the gas in the measuring vessel is to its normal or corrected volume. For the case of measuring gas over water, or in presence of water, the ærorthometer is charged with a drop of water. For technical purposes the graduation "1000" denotes the volume which the inclosed air occupies at 30 inches Bar. and 60° Fahr.

A Revision of the Atomic Weight of Rubidium, by Charles T. Heycock, B.A.—The object of this revision is to ascertain whether the atomic weight of rubidium can be brought into accord with Prout's hypothesis. To this end pure chloride and bromide of rubidium have been prepared, and the amount of chlorine and bromine contained in these, determined by titrating with silver nitrate in a manner identical with that employed by Stas in his classical researches. The results obtained from the chloride give an atomic weight of 85·344 for rubidium, whilst those obtained with the bromide, which the author gives with some reserve, show the atomic weight to be 85·387. These results show that, at present, rubidium cannot be regarded as conforming to Prout's hypothesis.

Method of obtaining Ammonia from Shoddy and Allied Substances, by W. Marriott, F.C.S.—A description of the method of burning shoddy moistened with soda in such a way as to collect the ammonia from the gases produced, and also utilise the combustible gases formed at the same time.

On the Application of the Diamond to Mineralogical and Chemical Analysis, by Prof. von Baumhauer.—The author after describing the various modifications of the diamond, gave an account of some methods in which the diamond might with advantage be employed in mineralogical and chemical analysis for the purpose of reducing hard substances to a fine state of division.

On the Occurrence of Tellurium and Selenium in Japan, by E. Divers, M.D., Professor, and Masachika Shimos, Student of Chemistry in the Imperial College of Engineering of Japan.—At the last meeting of the Association a communication was received from Dr. Divers in which it was shown that these elements are found in Japanese sulphuric acid. In this paper a description is given of the sulphur used in the manufacture of the acid, it differs from ordinary sulphur by being reddish-yellow in colour, and is known as *sekiriuscki*, or massive red sulphur, and is obtained from Iwoshima (sulphur island), a specimen of this red sulphur was found to contain 0·17 per cent. of tellurium and 0·06 per cent. of selenium. It is a matter of some interest that tellurium is found associated with sulphur in this state, as it is more usually associated with sulphur in a state of combination with the metals. Analysis of the mud-like deposit found in the vitriol chambers show it to contain some 10 per cent. of selenium and 1·2 per cent. of tellurium, and the sulphuric acid was found to contain 0·37 grams of tellurium and 0·15 gram selenium per liter. Attention is drawn to the fact that whilst the relative proportion between the quantities of tellurium to the selenium is as 5 to 2 in the sulphur, and as 5·5 to 2 in the liquid, it is as 1 to 9 in the deposit. This is easily explained by the fact that finely divided tellurium easily undergoes oxidation in presence of water and air whereas selenium is not so affected. Selenium and tellurium have been obtained by distilling the deposit in clay retorts.

On the Action of the Component Salts as Nuclei on Supersaturated Solutions of certain Double Salts, by John M. Thomson, F.R.S.E., F.C.S.—In a paper published in the *Journal* of the Chemical Society, May, 1879, the author has shown that if a mixture of dimorphous salts be taken, a separation may be effected by touching the solution with a crystal of one or other of the salts; a separation depending on the relative solubilities of the two salts. The investigation has been extended to supersaturated solutions of double salts, and the action upon these of the components of the double salts. Experiments have been made with solutions of double chlorides of mercury and ammonium, of mercuric chloride and ammonium bromide, of mercuric and potassium iodides, and of mercuric ammonium bromides. In these cases it has been found that the salt of the heavy metal is invariably active in producing crystallisation, whereas that of the alkali constituent is inactive. It has also been observed that the true prismatic forms of mercuric chloride and bromide produce crystallisation at once; but that if crystals of other forms are employed, as when obtained by deposition at a higher temperature, then the result is not always so defined. This is no doubt due to the fact that the first form of the heavy metallic salt is more nearly allied to that of the double salt. It appears, therefore, that these double salts of monobasic acids, although forming good supersaturated solutions, are not so firmly united together as to resist the disturbing influence of certain of their constituents, yet the disruption is not sufficient to produce a decomposition, and so a deposit of the double salt is obtained. Experiments with the double salt of mercuric cyanide and ammonium chloride, show that each constituent is active. In the case of the alums, the double phosphates and arseniates neither constituent is active. With Lefort's salts, viz. double sulphates of copper and zinc, both constituents are active, the zinc salt produces the more rapid crystallisation, but the double salt is deposited in each case. In the case of the double tartrates of sodium and potassium it was found that the potassium salt is inactive, whilst the sodium salt is active. An examination of the crystals showed them to have the composition of Rochelle salt; and since the nucleus in no wise resembled this salt in form, it would appear that rochelle salt is probably dimorphous. The activity of sodium tartrate is probably due to its being less soluble than potassium tartrate. In the case of the double citrates of these metals both constituents are active, whilst with the citrates of magnesium and sodium both constituents are inactive. These results show that the union in the double salts of monobasic acids is more of a molecular character, inasmuch as they suffer disruption more easily than do those formed of acids having a higher basicity, such as the alums and phosphates, where there is a firmer union of the constituent salts.

The Decomposition by heat of Potassium Chlorate, by Professor I. M. Crafts and A. Rilliet.—The authors have observed that the addition of metallic silver reduced from the chloride aids this decomposition, an observation which appears to destroy the usual theories regarding the function of those metallic oxides, which have a similar effect. It was supposed that the action of the catalytic bodies might arise from a power to absorb oxygen, but experiments made by placing black oxide of manganese under conditions similar to those in which it aids the decomposition of potassium chlorate, negatived this supposition. Gas retort carbon can be completely burnt by contact with powdered potassium chlorate at 340°, the action is not attended by fusion, and it appears that in this case chemical affinity determines the decomposition. The action of heat upon potassium chlorate was studied by maintaining it at a constant temperature, and it has been observed that the chlorate begins to give off its oxygen between 330°—340°, *i.e.* at temperatures much below its fusing points. This decomposition goes on for several weeks and finally becomes imperceptibly small, but a rise of temperature or the addition of substances known to favour the decomposition, produce a fresh decomposition leading to a further limit. The authors propose a hypothesis to account for this gradual action of heat upon the chlorate.

SECTION C—GEOLOGY

On the Cause of Elevation and Subsidence of Land, by J. S. Gardner, F.G.S.—The paper claims that the evidence of the permanence of continents is inconclusive as regards eocene and pre-eocene periods, and inquires what the shallower regions of the Atlantic mean, if they do not mean a change of level at the sea-bottom. Assuming with Sir C. Lyell, that at a given depth rocks are molten, and that under further pressure they are reconverted into solids of high specific gravity, the paper demonstrates that the outer envelope is susceptible to and gives way under any increased weight, and recovers when this is removed. The evidence relied upon is that of coral isles, lava-flows, accumulations of ice, and of sediment in deltas, estuaries, and along sea-coasts. In these cases, unless there are counteracting agents, subsidence invariably follows, and littoral seas are thus areas of depression. The increasing pressure in deep oceanic basins acting on the fluid layer leads to the elevation of lines of least resistance into ridges or dry-land, these lines generally coinciding with coast-lines, and to volcanic outbursts. Geology demands pre-eocene communication between many lands. The elevation of land continuous between Europe and America in the north, during the Middle Eocene, was coincident with a cessation in the great formation of basalt, and its subsidence with a renewal of this. The conclusion is drawn that irregularities of surface have and will continue to become more and more accentuated.

Notes relating to the Drift Phenomena of Hampshire: (1) *Boulders, Hayling Island;* (2) *Chert Débris in the Gravel;* (3) *Elephant Bed, Freshwater Gate*, by Prof. J. Prestwich, M.A., F.R.S., refers to the remarkable boulders of crystalline and other old rocks in Pagham, which were noticed long ago by Mr. Dixon, and more recently Mr. Codrington has described similar boulders of Portsea Island, and states that boulders of the same character occur in the gravel of Portsea Island, two boulders of granite, and three of sandstone occurring on the shore near the station, while thirty smaller specimens occurred within a mile westward of the station. Those on the shore facing South Hayling have been collected to form a rockery and local grotto work. The author considers the boulders to have been brought from the Cornwall and Devon coast by floating ice, at the time of the formation of the Brighton raised beach.

On the Sources of the Salt Supply of India, by Prof. V. Ball, F.R.S., states irrigation in some of the central districts in India has produced sterility, by raising the permanent level of the subsoil water in the ground, which becomes saline by contact with the lower strata, and through capillary attraction, salts of sodium potassium and magnesia were brought to the surface. The author states there are five distinct sources of salt in India, the most important of which are wells which have been sunk to a depth of 100 to 150 feet, and brine obtained, over a large area in the central region of India. In Assam and Burmah saline springs occur in connection with petroleum, 10,000 tons of salt are now being raised from the Sambur Lake. Rock salt occurs of Silurian age, and also in beds of Eocene Tertiary age.

On the Identification of certain Ancient Diamond Mines in India, by Prof. V. Ball, M.A., F.R.S., F.G.S.—The vague references to India as the only then known source of diamonds by the writers of 2000 years ago, give place to more definite indications of position in Sanscrit works of the sixth century, and possibly of somewhat earlier dates. In the Barhat Sanita a list of localities is given, but as the stones from some of the localities therein mentioned were copper coloured, it is possible that they were not diamonds. In the Ain-i-Akbari (1590), and also less clearly in the Ferishta's History (1425), a locality named Alheniguras is referred to, which can be identified with Wairugurh in the Central Provinces, where the remains of ancient mines are still to be seen. The following localities mentioned by Tavernier (1665), had not been identified until lately, though various attempts had been made by Colonel Rennell and others since his time. Gani or Coulour is Kollur on the K'stna; Raolconda is Ramulkota in Karnul; Soumelpour was on the Koel river in the Palamow district of Bengal. Kollur would appear from Tavernier's statement to have been the mine where the Great Mogul diamond was found. The same stone is mentioned by Garcias ab Horto, who wrote 100 years before Tavernier. Prof. Ball is of opinion that this stone, which was probably found in the middle of the sixteenth century, was the original of the Koh-i-nur. The author referred to several other early authorities, and to the mythical stories which are connected with the accounts of diamond mining, for the origin of which he proposed explanations.

On the Geology of Cardigan Town, by G. W. Keeping, M.A. —The author considers the Geological Survey in error as to the horizon, on which they place the Silurian rocks, underlying this town.

Notes on the Bure Valley Beds and Westleton Beds, by H. B. Woodward, F.G.S., considers the introduction of the term "Chillesford clay," and its supposed identification with any laminated clay that occurs on any horizon in the Norwich Crag, to have been the source of the confusion at present existing. The author finds there is no division between the Bure Valley beds and the Norwich Crag below, and that Messrs. Wood and Harmer are incorrect in referring that the former deposits are Lower Glacial.

The Iron and Lead Measures of Tynehead, Alston, by Mr. C. E. De Rance, F.G.S., of H.M.'s Geological Survey.—The Carboniferous Limestone of this area is split up into a series of limestone separated by thick beds of shale and sandstone, and traversed by an intrusive sheet of basalt, known as the Whin Sill; the section above that horizon consists only of about 200 feet of limestones, while sandstones reach 350 feet, and shales 520 feet. Beneath the Whin Sill there are 900 feet of measures, in which occur many important beds of limestone, one of which, the Melmerby Scar Limestone, reaches a thickness of 124 feet. The chief lead measures occur in the Great Limestone (70 feet), the Scar Limestone (30 feet), and the Tyne-bottom Limestone. The latter, deriving its name from its gradual inclination northward, forming the floor of the River Tyne; below this horizon but little has been done in proving the lead lodes in depth, owing to the water-charged condition of the rocks beneath. The veins in nearly every case are faults of small throw, when these traverse limestones, the veins contain lead; when they pass through sandstones they contain copper, and in both cases the sides consist of valuable deposits of brown hæmatite, which occasionally reach a thickness of 6 or 7 feet. These at present are not worked, but should a railway be carried up the Tees and into the South Tyne Valley, as is proposed to connect Alston with Middleton in Teesdale, these valuable deposits will be available for use in the Middlesboro district.

Notes on Alpine Post-Carboniferous (Dyassic) and Triassic Rocks, by the Rev. A. Irving.—This paper is merely supplementary to what has recently appeared in the *Geological Magazine*, on the Dyas and Trias of Europe. Attention is especially drawn to the three following points in connection with the Alpine Dyas ("Permian"):—(1) the occurrence of the *Verrucano*, its possible equivalence with the Rothliegende, as advocated by Gümbel, in opposition to the view of von Hauer, who prefers to regard it as belonging to the lowest horizon of the Trias; (2) the great volcanic activity manifested in the Alpine area in post-Carboniferous times, as illustrated by the great porphyry district of Bozen (in connection with which the structure of the Ritterer Horn, a "stratified cone," with interbedded "ash" beds and porphyries, is described from recent observations by the author); (3) the occurrence of certain Alpine deposits (especially the Bellerophon Limestone of the Puster Thal, and the Grödner Sandstein at Neumarkt near Bozen), which, on palæontological grounds, are regarded by Gümbel as representing a "*transition series* from the Dyas to the Trias." Attention is also drawn to the correlation of the Triassic deposits on the northern and southern sides of the great crystalline axis of the Alpine chain, and in particular to the apparent identity of horizon occupied by the massive Schlern dolomite, with its underlying St. Cassian Beds, and the Hallstatt Limestone with its underlying marls rich in St. Cassian fossils. This point is illustrated by sectional diagrams, one through the Steinernes Meer (after Mojsisovics), the other through the valley in which St. Cassian is situated Numerous fossils recently brought from the St. Cassian district were exhibited.

On the Post-Miocene Deposits of Bovey Tracey, South Devon, by W. Pengelly, F.R.S.—Lignites with detrital gravel are of Lower Miocene or Upper Miocene age, and certain sub-tropical faults, *Betula nana* beds of later date, of post-glacial age; the so-called "head" is of somewhat older age, and is referred by some to the glacial epoch. Described clay with angular smoothed stones, considered to be Boulder Clay by Prof. Heer and other foreign geologists, but the author has failed to find any scratches upon the stones. 9 foot 6 inches below the surface is a bed of white clay with *Betula nana*. The author described the discovery of a canoe in the midst of clays, which he believes of older age than the era of *Betula nana*, and reports it to be probably of inter-glacial age if the head was of glacial age.

Problems on the Geology of the Channel Islands, by Rev. E. Hill, M.A., regards the work of the late Prof. Ansted as incomplete. The author considers that probably the Homoblendic rock overlie the groups of sark, but this requires working out. States that Prof. Ansted's conclusions as to the lithology of the rocks, are not founded on sufficient basis. He regards the work of Prof. Liveing as of considerable value in this direction, but he considers that there is much to be done in Guernsey, Sark, and Jersey. He describes basaltic dykes, dioretic dykes, and of mica-trap in Guernsey, the latter being in Sark.

The Southampton Artesian Well, by T. W. Shore and E. Westlake.—The question is, whether it is possible by an extension of the existing well, to utilise it as a source of supply to the town. The amount of water yielded by the well on the last occasion of pumping, in 1851, was 130,000 gallons per day. The quantity of water at present supplied to the town from the Itchen is from 3 to 3½ million gallons, but this is a much larger quantity per head than is found to be sufficient for towns under well regulated systems of supply. It thus appears that the well yields about 1-25th part of the quantity required. For the purpose of increasing the yield, two methods are suggested: one of them is to drive galleries or drift-ways in the chalk, the other is to continue the boring through the chalk into the Upper and Lower Greensands. The work of excavation was carried on from July, 1838 till 1851, at a total cost of 19,000*l.*, and reached a total depth of 1317 feet. The diameter of the well was 13 feet, diminishing to 7 feet; it passed through 464 feet of the Tertiary Beds, of which soil occupied 2 feet, Lower Bagshot bed 74 feet, 304 feet of London clay, the latter consisting of sandy clay with seams of water-bearing sand and pebble beds towards the top; 84 feet of Plastic Clay, with the usual bed of greensand on the bottom. The chalk was reached at a depth of 464 feet, where the masonry was terminated, but the 7-feet shaft was carried 99 feet into the chalk; a 7½ inch boring was then made with a 7½-inch augur to a further depth of 754 feet, making a total of 853 feet of chalk. The whole of the chalk contained flints, with the exception of the last 10 feet. Most of the water met with appears to have come from the chalk; previous to the boring being made, in 1842, 20,000 gallons was raised. In 1844 the quantity rose to 50,000 gallons, and finally in September, 1851, to 130,000. The chalk thus supplies 5-6ths of the whole quantity. The authors then give a description of the Brighton chalk wells, and they consider the conditions are similar at Southampton. The authors, following the advice of Dr. Buckland at the previous meeting of the British Association, have ascertained the height of the Greensand springs:—

Springs.		Height of Springs.	Height of Water in Well
Petersfield	Twyford	210	—
	Petersfield	300	150
	East Wordham	390	—
Kingsclere		—	137
Pewsey Warminster	Avon at Wivelsford	340	123
Wardour	Wiley at Boreham Bridge	337	112
Shaftesbury	Nadder at Barford	200	87

The authors are of opinion that large stores of water may be obtained by sinking into the Greensands.

On the Synclinal Structure of the Straits of Dover, by W. Topley, F.G.S.—Transverse valleys of the Weald, now dislocations or anticlinals, but, on the contrary, lie in synclinal flexures, this is observable in all the valleys of the Weald. The author considers there were six valleys on the north side of the Valley of the Weald, five of which still exist. The sixth intersected the Straits of Dover, its upper tributaries and the Rother, which now enters the Channel at Rye.

On Subsidence as the Effect of Accumulation, by Charles Ricketts, M.D., F.G.S.—There is no fact in physical geology more frequently recorded than that, whilst the deposition of sedimentary strata has been in progress, there has been simultaneously a subsidence of the earth's crust; though but little effort has been made to determine whether they are dependent on each other as cause and effect. Boring in deltas prove that depression to a great extent has occurred whilst the accumulation was being deposited. The greater amount of detritus derived from hills and valleys is carried into the sea, but, instead of filling it up, the water becomes of a great depth at a few miles from the mouths of large rivers. There was a progressive subsidence of the land during the glacial period; this may be ascribed to the weight of accumulated snow, and of the newly-formed boulder-clay; a similar depression is occurring in Greenland, under a rapid increase of snow. The carboniferous series above the limestone afford most satisfactory evidence that the amount of subsidence coincides with that of deposition; the surface of the limestone and the beds of coal furnishing sufficiently correct base-lines for determining the question. There must needs be a cause for this universal occurrence of subsidence with deposition of strata, the only efficient one being the weight of the accumulated material pressing down the crust of the earth resting upon a fluid substratum. Elevation also happens on the removal of pressure, and "those regions which have suffered the greatest amount of denudation have been elevated most."—(Capt. Dutton, U.S. Ordnance Survey). At the termination of the glacial period, the land, depressed by its load of snow, became, upon this melting away, re-elevated to a certain extent. This, and the rising of the land at the present time in Norway and Spitzbergen, may be attributed to the removal of a thick covering of snow. In elevated districts the highest parts are those in which there has been the greatest amount of denudation, and often consist of the lowest rocks in a geological series. The author thinks that these depressions and elevations cannot be ascribed to secular cooling of the mass of the earth, since by such action the accumulation cannot also be accounted for; nor could the same agency acting only in one direction cause both depression and upheaval. The concurrent pheomena of accumulation and subsidence, and their converse, demand serious and careful investigation; especially as in them may be found the great moving-power upon which depends the greater number of geological changes.

On the Origin of the Hæmatite Deposits in the Carboniferous Limestone, by Edward Wethered.—The author contended that the so called "pockets" of hæmatite which occur in the Carboniferous Limestone were caverns and fissures into which the ore had been introduced by water agency. There were two or three signs which indicated an approach to a pocket of ore:—1. Joints appeared in the rock, through which water percolated. 2. An ordinary cavern opened out, termed by the miners a Welsh "locus," the sides of which were coated with large crystals of carbonate of lime. 3. Traces of iron are found in the "locus." The fact that the first indications of ore were cracks in the rock, down which water percolated, certainly pointed to the inference that by a similar percolation the hæmatite has been brought into its present position. That it has been deposited by aqueous agency was clear from the crystalline character of some of the ore. Further, there was just what would be expected from water containing the carbonates of lime and iron in solution when not exposed to the atmosphere, namely lime has been first deposited, and subsequently hydrated peroxide of iron. The next point considered was, from whence was the iron derived. The highly ferruginous character of the Carboniferous strata was well understood, and the fire-clays indicated that large quantities of iron had been rendered soluble by the deoxidising influence of decaying vegetable matter, and removed by the percolation of water. But as to whether it was this iron which had given rise to the Carboniferous Limestone hæmatite deposits was a matter for consideration. It was doubtful whether there would have been sufficient time for the fissures and caverns to have so far developed as to form receptacles for the Coal-measure water charged with carbonate of iron. It must, however, be remembered that after the uplifting of the Palæozoic rocks there was a vast lapse of time during the denudation by the Triassic Sea, and that much of the limestone, not now overlain by the Coal Measures and Millstone-grit, was covered by those beds for a considerable time. Further, water percolating through the Coal Measures would become highly charged with carbonic acid, given off from vegetation undergoing transition into coal, and water, so charged, would not be so long in dissolving and eroding out caverns. Mr. Etheridge had referred (*Quart. Journ. Geol. Society*, 1870, ix. 185) the origin of the Carboniferous hæmatites, in the West of England, to the infilling of faults, fissures, &c., during the denudation by the Triassic Sea; but stated that "doubtless the percolation of water through overlying strata, highly charged with oxides of iron, had been a source and mode of accumulation." Though the author was disposed to consider it possible that some of the hæmatite may have been derived from the percolation of water through the Coal Measures and Millstone-grit, yet he agreed with Mr. Etheridge that the most probable source was from the Trias rocks; not, however, during the accumulation of the strata composing that formation, but by subsequent percolation of water after consolidation of the beds. This water, on arriving at the Carboniferous Limestone, would flow down the cracks, fissures, and joints, provided there were such, but a comparatively small portion would filter through the actual rock on account of its being but slightly pervious to water. The author considered that it was owing to this fact that we generally find hæmatite where the Magnesian Conglomerate rests upon the Carboniferous Limestone. The water being unable to penetrate the rock, would naturally find an outlet at the junction of the two formations, and by the wearing away of the rock the conditions would soon be arrived at when the deposition of the iron would take place.

NOTES

THE concluding meeting of the French Association at La Rochelle was rather stormy, although not more than 203 members were present. M. Bouquet de la Grye was nominated vice-president for 1883 and president for 1884. Although very few members took part in the work of the meeting, sixteen different sections were kept in operation; this extreme division has somewhat impaired their activity. However a number of interesting papers were read and discussed. M. Debrun, Professor in the College of Pau, described a new system of central magazines for distributing electricity, a new balance for determining by mutual repulsion of currents their relative force, and a new registering electrometer. M. Marcel Deprez presented a new apparatus for determining the mechanical equivalent of heat, based mostly on Leon Foucault's experiments. He hopes to determine with a sulphurous acid calorimeter the real value of this coefficient with an approximation of $\frac{1}{1000}$th. M. Tissandier presented again his researches on light bichromate elements; he contends that he obtains regularity of action without renewing the liquid, and without insuflation. Dr. Landowsky delivered an eloquent address against the dangers of injecting morphia, as practised nowadays by so many people. He deprecated strenuously this new method of intoxication; he calls it morphiomania or morphinism. Dr. Audrat has paid special attention to the anæmia of miners, and described it in a very interesting address. Electric lighting experiments were tried in the rooms of the Hotel de Nantes by a new system invented by M. Debrun.

ADMIRAL MOUCHEZ has been visiting the Pic du Midi to ascertain whether astronomical observations could be conducted successfully there.

THE *Standard's* New York Correspondent telegraphs that Mr. Edison's system of providing an incandescent electric light for domestic use in a given district has just been put to a practical test in that city. The district selected occupies an area of nearly a square mile. Only one source of supply is provided, and that furnishes the illuminating power for sixteen thousand lamps, the electric current passing through eighteen miles of mains. The result is that the severest demands which the consumers have been able to make upon the new system have been satisfied. The *New York Herald* is using in its business premises an isolated plant on the same principle. No new obstacle has presented itself to the success in practice of Mr. Edison's theory; and scientific men, the Correspondent states, will be interested to know that this first practical experiment demonstrates the soundness of the inventor's application of the multiple arc system, pure and simple, as distinguished from the series system, or the combination of the arc and series systems. Throughout the entire district lighted as described, each lamp was independent of all the others.

THE electric illumination of the Vaudeville, on the Boulevard Montmartre, is a great success. The hall is crowded every night. An 11 horse-power gas machine with Faure accumulators is sufficient to illuminate every night about 250 Swan lamps.

CONSIDERABLE interest was expressed by many visitors to the Ordnance Survey Office during the British Association meeting at Southampton, that the old and costly process of reducing the 25-inch maps to 6-inch scale, and engraving them on copper-plates, of which moulds had to be obtained, and electrotyped replicas had to be made, from which the copies were printed off, has been superseded by a cheap and rapid process, by which maps can be at once reduced and published on the 6-inch scale, so soon as the 25-inch scale is completed; by a simple application of photography the lines are reduced to any desired scale, and at once transferred to an inexpensive zinc-plate. The new 6-inch map, produced by the photozincographic process, adopted by the Survey in their reproduction of the Doomsday Book, will in future be issued for all the counties of England and Wales, where no 6-inch maps exist engraved from copper plates, but in those counties where a portion of the area has been published, on the latter system, the old process will be continued to secure uniformity. The new 6-inch maps are smaller in size than those formerly published, and at present are not contoured, but their lines will be added in subsequent editions. Their publication will at once permit the much-required completion of the Geological Survey of our coal-fields, which is a matter of the most urgent necessity.

WE regret to learn of the death, at Dorpat, of Dr. Kreuzwald, the publisher of old Esthonian songs and poems. He was born in 1804, and studied medicine at Dorpat. When a student he began to collect songs and tales of his country-people, and in the years 1840 to 1850 he published a series of remarkable articles on Esthonian antiquities, mythology, traditions, and tales. His principal work was the publication, with annotations, of the whole of the different parts of the great Esthonian poem, "Kalewinoey," remarkable by its fine poetical feeling for nature and analysis of human feelings. It was translated into all the chief European languages. In 1877 Dr. Kreuzwald was compelled to abandon his medical practice, and died in poverty at Dorpat.

THE *Official Messenger* of St. Petersburg announces, on September 1, that "by order of the Emperor the admission of new pupils to the course of medical training for women, at the Nicholas Military Hospital, will be discontinued after the present term. The students will be allowed to conclude their course, after which the clinical instruction for women at the hospital will be abolished." The Medical Academy for Women, the courses of which were quite equal to those of the old Universities, had 367 students. Since 1877, when the first lady students passed the examinations, 281 ladies have completed the whole course of studies, and 152 had passed the examinations of M.D.; 105 of them were in service at universities and in public hospitals.

NEWS received from the Finnish Circumpolar observation party states that the members arrived at Sodankylä in the north of Finland early in August, and that observations commenced there on the 15th ult. as intended.

M. Rabot, a member of the French Geographical Society, has sailed from Tromsoë to Spitzbergen for a private exploration. This is the first time that a French ship has been in these seas for exploring purposes since *La Silvisse* was sent during the reign of Louis Philippe, under the command of Blosseville. This ship was lost, and nothing was ever heard either of it or any of the crew.

We notice a good book of travel in Servia, published by Franz Scherer under the title, "Filder aus dem Serbischen Volks- und Familien-leben."

There has just been published an elaborate work on the present state of silk-worm culture in Southern Russia and Trans-Caucasia, giving an accurate description of the whole of the culture, and a complete bibliography of works on the subject that have appeared since 1703. It is published in connection with the Moscow Exhibition, by the Moscow Agricultural Society, with many plates of drawings.

We have received part 3, vol. iii. of the *Transactions* of the Norfolk and Norwich Naturalists' Society. We observe from the presidential address that the strength of the Society continues to increase, the present number of members being 234 as compared with 204 in the previous year; the financial position of the Society is also satisfactory. Amongst the published papers is a biographical notice of the late Dr. S. P. Woodward, by his son, Mr. H. B. Woodward, F.G.S. This memoir forms one of a series which the Society is publishing of distinguished naturalists connected with the county of Norfolk. A paper on the extensive destruction of the Lombardy poplar, contributed by Mr. H. D. Geldack, has also more than local interest. Mr. Stephenson's paper on the plumage of the waxwing contains some valuable additions to the history of this beautiful and singular bird. Additions to the fauna of the county are made in the Mammalia by Mr. Southwell, Hymenoptera by Mr. Bridgman, the Tortricidæ by Lord Walsingham, and to the Flora by Mr. A. W. Bennett, F.L.S. There are also papers on the noteworthy springs and spas of Norfolk by Mr. H. B. Woodward, F.G.S., the herring fishery of 1881, and some interesting notes on the habits of the nightingale, extracted from a letter written to the Rev. R. Sheppard in 1819. In addition there are ornithological and entomological notes from Mr. F. D. Power, Mr. Frank Norgate, and Mr. Stevenson.

Messrs. Piper and Carter have issued a new edition (the fifth) of Capt. Abney's "Instruction in Photography." The whole of the work has been revised, sixty pages of new matter added, and the latest details as to the gelatine emulsion process given.

We have received from Mr. Stanford other two war-maps. One of Lower Egypt, on the scale of 4 miles to the inch is extremely minute in detail, and will be found of great service in following operations. The other contains a map of the Nile Delta, a plan of Cairo and its environs, the towns and ports of Suez, Ismailia, Port Said, and a general map showing the Suez Canal and Cape routes to India.

The English Government having sent to Egypt theee of the Woolwich balloons, we may remind our readers that balloons were taken out by the French army in 1794. But it was impossible for Buonaparte to use them, the furnace for the preparation of pure hydrogen having been lost when the French fleet was annihilated by Nelson in Aboukir Bay. Conte, the engineer of the aëronauts, was created the head of Cairo arsenal, and Coutelle, their captain, was sent on a scientific mission to Upper Egypt. The diameter of these French balloons being small (10 metres), their capacity was only 520 cubic metres; they were of silk, and always inflated with pure hydrogen, which was prepared by the action of steam on iron filings.

An exhibition of considerable interest has been opened at the Royal Aquarium, consisting of a Javanese "Gamelon" or orchestra, of fourteen male and four female performers. There is a variety of percussion instruments and one stringed instrument stated to be a violin of the Chinese type. The females go through one of their native dances, if their peculiar postures and movement of limbs and head may be regarded as a dance. From an ethnological point of view, the exhibition is well worth a visit by those who have not had an opportunity of seeing the Javanese at home. With considerable general likeness, there is really great diversity of feature, one or two of the faces being almost European in type.

The Swedish Government has decided not to prohibit vivisection in that country, in spite of the appeal made to them by the Diet in reference hereto last session.

About forty male pupils of the Parisian public schools who have taken honours have been sent on a visit to London. The Société Nationale Française have made arrangements for their board and guidance. The same number of laureates were sent to Central France.

Two very large and splendid catseyes were exhibited at the *conversazione* of the British Association at Southampton by Mr. James R. Gregory. These were said to be the largest in the world; one of them measured 3 inches in length and 1¼ in. in breadth, and weighed 359 carats, or nearly 2½ ounces; the other is somewhat smaller, weighing 308 carats. They are both remarkably fine stones.

The additions to the Zoological Society's Gardens during the past week include two Southern River Hogs (*Potamochœrus africanus* ♂ ♀) from South Africa, presented by Col. J. H. Bowker and Mr. John Dunn; a Hairy-footed Jerboa (*Dipus hirtipes*) from Jeddah, presented by Mr. Lionel Adams; a Himalayan Bear (*Ursus tibetanus* ♀) from North India, presented by Mr. E. J. Coope; an Indian Chevrotain (*Tragulus meminna*) from India, presented by the Hon John Stoddart; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mrs. Crawford; two Crimson-winged Waxbills (*Pytelia phœnicoptera*) from West Africa, presented by Mr. Albert Krebl; a Four-coloured Shrike (*Laniarius quadricolor*) from South Africa, presented by Col. J. H. Bowker; a Red Brocket (*Cariacus rufus* ♀) from Brazil, a Grey Squirrel (*Sciurus cinereus* var. *nigra*) from North America, seven Madagascar Boas (*Pelophilus madagascariensis*) from Madagascar, deposited; a Yellow Baboon (*Cynocephalus babouin*) from West Africa, four White-headed Bullfinch-Larks (*Pyrrhulauda verticalis*) from South Africa, two Yellow Sparrows (*Passer luteus*) from East Africa, two Scarlet Ibis (*Endocimus ruber*) from Para, two Crested Colins (*Eupsychortyx cristatus*), eleven Variable Leaf Frogs (*Phyllomedusa dacnicolor*) from Mexico, purchased.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

University College, Bristol, is making laudable efforts to provide a complete curriculum for the important district of which it is the centre. Like the similar colleges at Manchester, Leeds, Birmingham, &c., the lectures comprise all the branches of a liberal and scientific education. The erection of new buildings, which will be completed before the close of the current year, will give increased facilities for the study of science. The Chemical Department now contains accommodation for nearly fifty students, and is, we believe, equipped with the latest improvements for teaching which are in use in this country or on the Continent; lectures are delivered on pure chemistry as well as on certain branches of applied chemistry. The physical and engineering departments are also provided with facilities for laboratory work. The instruction in experimental physics is kept abreast of the rapidly increasing requirements of the age, and arrangements are now perfected for the training of students as electric engineers—a profession for which the recent development of electric discovery opens good prospects. The Bristol Medical School, which is affiliated to the College, offers with the Royal Infirmary and General Hospital, every facility for the study of medicine. Instruction in biology is also given, and it is intended to open a biological laboratory in the course of the ensuing session. In other subjects the instruction is such as to make the curriculum practically complete.

THE Calendar of the Mason College, Birmingham, already extends to 250 pages. The list of professors is fairly complete, and the subjects cover pretty well the whole field of a liberal education. Science, of course, has a prominent place, both pure and applied, but literature, both ancient and modern, is as fully represented as could be desired. The examination papers are given, and are up to a high standard; and the College as a whole promises to fulfil the intentions of its liberal founder.

THOUGH in a less advantageous position so far as funds are concerned, the modest little Calendar of the Newcastle College of Science shows that every effort is being made to keep it up to the mark. It is a pity some of the rich coal and iron masters of the northern districts do not come forward and give the struggling institution a helping hand; they could not do the north a greater service.

AN important movement is taking place among the manufacturers and machine makers of Nottingham to promote the establishment of a first class technical school in connection with the University College in that town. A nucleus fund for this purpose has been provided by the Drapers' Company in a grant of 300*l*. per year for five years, with an additional 200*l*. in the first year for the purchase of apparatus. This grant is, however, subject to certain conditions, and is also to some extent dependent on the amount of local enterprise which is displayed. The company, after mature consideration, and upon the report of Mr. Magnus, the director of the City and Guilds' Technical Institute, who, with certain members of the Drapers' Company, visited Nottingham to make inquiries, resolved to make the grant through the Institute, and the instruction provided by it is to enable students, artisans, and others to present themselves for the Institute examination in mechanical engineering. A course of instruction in practical mechanics is to be given by a professor of physics and mechanics in the evening, and the services of a skilled fitter are to be obtained to act under the professor in the practical explanation of the tools and the machinery used in lace and hosiery manufacture. The local committee are now arranging for the setting apart of portions of the College for this special purpose.

AT a meeting of the Council of the Yorkshire College, held on September 2, Mr. N. Bodington, M.A., Fellow of Lincoln College, Oxford, and Professor of Greek and Latin in the Mason's Science College, Birmingham, was elected to the Professorship of Classics, vacant by the resignation of Prof. Marshall, and to the Principalship of the College.

A NEW University building, which has taken two years to construct, will soon be opened in Lund.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 9.—Experimental contributions to a knowledge of the electric conductivity of flame-gases, by W. Giese.—On absolute systems of measurement for electric and magnetic quantities, by H. Helmholtz.—Proof of the existence of Maxwell's electromotive force V_{me}, by R. Colley.—The electric conductivity of sulphuric acid and pyrosulphuric acid, and the density of concentrated sulphuric acid, by W. Kohlrausch.—The specific heats of gaseous biatomic compounds of chlorine, bromine, and iodine with each other and with hydrogen, by K. Strecker.—Researches on the absorption of gases by liquids under high pressures, by S. v. Wroblewski.—On the motions of air on the surface of the earth, by A. Oberbeck.—On Newton's dust rings, by K. Exner.—On the action and piezo-electric properties of rock-crystals and their relation to the thermo-electric, by W. G. Hankel.—Note on an explosion of a glass tube filled with liquid carbonic acid, by L Pfaundler.—On an explosion of an oxygen gasometer of sheet zinc, by the same.

Rivista Scientifico-Industriale, June 15.—Elementary geometrical demonstration of the condition of minimum or maximum deviation of a homogeneous ray sent through a homogeneous prism, by Prof. Banfi.—On the reductive action of glycerine on salts of silver and application of this phenomenon to silvering of glass, by Prof. Palmieri.—On *Palæomonetes* varians and one of its varieties, by Prof. Garbini.

June 30 and July 15.—Anemoscope and anemometer with free transmission, of the Brothers Brassart, by S. E. Brassart.—On unequal heating of the two electrodes by the electric discharge, by Prof. Giovanni.—Movements, ruptures (lithoclases), and tangential pressures the direct causes of the axial elevation of the Northern Apennines, by Prof. Bombici.—Contribution to study of anthropology of the southern provinces; prehistoric objects of Molise, by Dr. Del Lupo.

Bulletins de la Société d'Anthropologie de Paris, tome v. 2 fascicule, 1882, contain: Papers by M. de Mérejkowsky, on a series of Sardinian crania, with explanatory and metric tables, and on certain American crania belonging to the Araucanian, Moxo, and other native tribes of the north-west and west districts.—A report of the discussion at the meeting of March 2, on the relative weight of the brain, with reference specially to M. le Bon's views on the invalid character of determinations based on means, and to the conclusions which he has drawn from his own methods of comparing the relative weight of the body and brain in boys and girls.—A communication from M. de Ujfalvy, on his travels in the Western Himalayas, with the results of his craniometric and other determinations among the local tribes, more especially in Kashmere, Lesser Thibet, and the Koulou country, where polyandry exists.—At a subsequent meeting of the Society, M. Beauregard gave a *resumé* of M. de Ujfalvy's observations of the ethnic and social character of these peoples, and of the records of ancient and modern travellers concerning these mountain districts, tracing the history of polyandry back to the Getæ and Massagetæ, whom he believes to be the ancestors of the Dardis, whose country is regarded by Dr. Leitner as the original seat of the Aryan race. (The discussions to which the communications of M. de Ujfalvy gave rise have led to the adoption of a resolution for the extension and more exact definition of the ethnographic observations included in the Society's Directions for travellers.)—M. F. Regnault reports the results of his recent excavations at Bordes in Ariège, where in an old moraine bed he has found two burial chambers below an erratic granite boulder. Both chambers, one of which was situated below the other, contained human bones, a cut flint, and fragments of pottery, some of which were marked with geometrical designs. In the discussion following M. Regnault's communication, M. Leguay drew attention to a similar chamber disclosed at Crécy in 1842.—M. de Mérejkowsky described an instrument designed to determine the relations of the nasal arch to other parts of the cranium with a view of establishing a new character for the better comparison of differences of race. This number ot the *Bulletins* closes with the first part of M. Le Docteur D'Hercourt's Topographical Survey of the Island of Sardinia, including the geography, meteorology, and natural products of the island.

CONTENTS

THURSDAY, SEPTEMBER 14, 1882

NAVAL EDUCATION

FROM the papers and discussions which have recently appeared in the *Journal* of the United Service Institution (Nos. cvi., cxv., 1880, 1882), it would appear that a large number of our naval officers are becoming sensible of the many defects of the system under which their younger brethren are at present entered and educated. In all professions it is so much the custom of the seniors of high rank to hold by the existing state of things, that the protest now made is the more marked, coming, as it does, not from one officer, or from a clique, but from officers of all ages, ranks, and branches, who look on the subject from different points of view, and correct their judgment by different forms of experience. The fact seems to be that, whereas the naval officer of former days was not called on to be anything but a seaman, though it was no doubt better if he was also a gunner—which was but seldom—at present he ought to be not only a seaman and a gunner, but half-a-dozen other things as well—a navigator, an engineer, a mechanic, an electrician, something of a soldier, something of a naval architect, skilled in signals and in tactics, and not ignorant of international law. There are, of course, but few who can excel in all these branches of knowledge; but every naval officer is expected to know something of all, and before getting his commission he has to show, in examination, that he does know something of all, even though that something may occasionally be very little: he is then permitted to choose one or two subjects of which he may make a specialty; he may devote himself to navigation, to gunnery, or to the management of torpedoes; and on showing that he possesses special qualifications, he receives special appointments and a higher rate of pay. But whether his tastes and abilities lead him to qualify in these special subjects or not, he is supposed to have a certain respectable knowledge of all; and, as keeping up the traditions of the service, he is required, before everything, to be a first-rate seaman. The most important question then is, Does the present system of training young officers ensure their becoming first-rate seamen? The answer of almost every speaker at the United Service Institution is in the negative. Capt. Brine, to whom the Institution has this year awarded its gold medal, says, "A midshipman serving in an ironclad has but few opportunities of learning the work of a sailor; it cannot be said that the years thus passed are essentially valuable as regards seamanlike training." Capt. Grenfell says, "We are all familiar with Falconer's admirable picture of the almost child handling a ship—'And well the docile crew that skilful urchin guides.' It would be useless to look for the same thing now. Our urchins, we must confess, are not "skilful." Capt. Cleveland says, "On board an ironclad, youngsters have very little opportunity of learning more than just the routine work, which they may learn from a book;" and Lord Dalhousie thinks "the ordinary life of a midshipman in a sea-going ship to be so ill-organised as to be little better than very laborious waste of time, so far as his own professional training and education are concerned." Many others might be quoted to the same effect, for the agreement is almost perfect; but these are sufficient. It may be assumed as admitted that a little boy sent on board an ironclad to learn seamanship, does not learn it, and has no opportunity of learning it, whether seamanship is understood in the old sense of handling a ship under sail, or in the modern sense of handling her under steam, and still less if in the strictly logical sense of "manœuvring ships under all circumstances of wind and weather." What our large ironclads have masts and yards for—except to foul and choke the screw in time of battle—is a thing often wondered over. Many have none, and even those that have them do not trust to them in performing the simplest nautical evolution. Clearly then a young gentleman on board such a ship does not learn the sailoring of the old school. How he can be supposed to learn the management of the ship under steam does not appear. Capt. Cleveland—who, as having lately commanded an ironclad, speaks with a special authority—says, "No captain would ever trust an ironclad to a young gentleman to work, as the captains of old did their frigates;" and evidently the mere being on board whilst somebody else is working the ship can teach him very little. His principal duties are, in fact, said to be seeing the ashes emptied overboard, the decks swept, and the brass rails polished; niceties which he might learn equally well on shore from his mother's housemaid, or by making an occasional round in the dust cart. Mr. Laughton, one of the Instructors at Greenwich, goes so far as to doubt whether this method of training young officers was ever quite satisfactory. "No doubt," he says, "in former days the still existing system of sending little boys on board ships on active service to learn seamanship by doing what they were bid and keeping their eyes open, answered *pretty* well. I do not think it did *very* well. Of course we turned out a large number of first-rate seamen, but it was out of an enormous number of entries. No account can now be taken of the failures; but of those who through ignorance, drink, and immorality went wholly to the dogs, the number was extremely large, and of those who did not thus utterly break down, there were a very great many who dragged on in the service as ignorant of seamanship as of everything else that was reputable." Even now the same evils are at work, though in a less degree; and in a former paper on a kindred subject, Mr. Laughton showed that "more than half the entries into the service disappear within twelve years," whether from "death, ill-health, family affairs, dislike, incapacity, or bad conduct."

Now it has long been maintained that the early lessons in seamanship, in the management of the ship and the men, were a sufficient and imperative reason for dragging little children off to sea. But since it appears proved by the concurrent testimony of many Admirals, Captains, and Commanders now serving, that our children so sent to sea do not learn seamanship, and that our young officers are thus, as a rule, curiously ignorant of real seamanship when they go up for their examination, this alleged sufficient reason falls to the ground; and many other reasons, which do not fall to the ground, prove that the system is a bad one. Let it be borne in mind what this system is. Little boys between the ages of 12 and 13½ years are selected by limited competition in an examination which Admiral Boys—himself for some time the Superintendent of the College at Portsmouth—describes as "simply an examination of their mothers or governesses, or the preliminary schools they may have been at." Their general education is then stopped; they are sent to the *Britannia*, and there, in the space of two years, they have to learn and pass an examination in a number of subjects, the list of which is utterly appalling. On this Prof. Soley, of the United States Naval College, says, "The course, as indicated by the examination papers, is far in advance of the mental powers of average boys of the prescribed age. The reason that more do not fail is to be found in the low standard of passing, and in the system of cramming carried out by clever tutors who are masters in the art of coaching pupils for examinations. No one seems to pretend that the students come anywhere near the ostensible standard, or carry away anything like real knowledge of the subjects embraced in the programme." And what little is learnt is extremely evanescent: within six months the majority have forgotten all about it. It appears from a report by Dr. Hirst, the Director of Studies, that in a recent examination, and in papers specially prepared, the young gentlemen six months out of the *Britannia* obtained an average of 32 per cent. in Arithmetic, 28 in Algebra, and 17 in Trigonometry. Now the *Britannia* is essentially a mathematical school, and the Instructors are —it is fully proved by their immediate results—able, hardworking men; but they are crushed by a radically bad system, which necessitates the "teaching mathematics and navigation from the wrong end." In this, the Instructors have no option; they are bound by an official schedule which requires the newly-caught children, knowing next to nothing of Algebra or Geometry, and very little of Arithmetic, to proceed at once to the solution of Plane and Spherical Triangles. Of course the little fellows learn to do these questions, because there is no passing for them unless they do do them; but "the knowledge is stuffed into them by a 'damnable iteration' sickening alike to the teacher and the taught." What is the result? We have shown that they pass out of the *Britannia* and straightway forget it all. A Naval Instructor of many years' experience assures us that his guiding rule has been to assume that a youngster joining his ship fresh from the *Britannia* knows nothing, and to begin him with the very elements of Algebra and Geometry. When this can be done, when the Naval Instructor is zealous and is supported by the Captain, when a suitable place can be found for study, and when the youngsters are industrious and clever, then, no doubt, very satisfactory results are sometimes obtained: but the difficulties in the way are exceedingly great. "Order it as you will," Mr. Laughton says, "on board ship the routine will always interfere with the school, and interruptions are frequent. Nor does keeping the middle or morning watch quicken a boy's faculties for study: with his eyes involuntarily closing, his head nodding over his book, the thermometer at 80° or 90°, and the perspiration dropping from the end of his nose—the difficulties in his way are very real. What a make-believe school, under such circumstances, often is, every Naval Instructor knows very well. The wonder is not that, with such a considerable expenditure of labour, so little is done, but that anything is done at all." The present day affords an example of another difficulty. What amount of school, we would ask, have the young gentlemen of the Mediterranean fleet done during the last three months? or, admitting that in some instances they have been present in the body, what amount of real study have they done? Our experience of boy-nature would lead us to answer—None. And after all these difficulties, the end is as might be expected: for a young officer in his final examination to show any real knowledge of his theoretical subjects is said to be quite exceptional.

The result then of the present system is that—speaking generally—the young officer, whilst a midshipman, learns neither the practical nor the theoretical parts of his profession: his time is muddled away: he gets a certain amount of crude knowledge crammed into him for his examination; and having passed that, if all desire of learning has not been crushed out of him, he has too often to begin again at the very beginning. In the majority of cases, Mr. Laughton tells us, an officer coming to the College for a voluntary course of study "does not know any mathematics at all"; and, he adds, "when men have got to the age of 25 or 30 without mastering the elementary principles of geometry and algebra, the task of then doing so is extremely irksome, and in many cases, utterly impossible." Now it is admitted, and—as we have said—by officers of long and special experience, that this state of things does exist, and ought not to exist; and there seems a very general idea that the remedy must be a radical one, and be applied at the beginning; that the foundation of mathematical knowledge ought to be laid before a boy goes to sea at all; and that the early part of his time at sea should be spent in a specially appointed training ship, and not in a ship on active service, where the instruction of the young officers is a point of very secondary consideration, if indeed it has any real place. Mr. Laughton proposes that the cadets should not be entered till they have learned their mathematics, and suggests that this should be tested, in a competitive examination, at an age ranging from 16 to 17. Capt. Grenfell would prefer entering them by nomination at 12, and keeping them in a college under the Admiralty for 4 or 5 years. Each proposal has its own advantages; but we prefer a free competition, at a reasonable age, to the nomination of children; and we see no reason why these elementary subjects should be taught, at the expense of the public, to lads who are in no way bound to the public service. But either one, or the other, or any similar scheme would be an enormous improvement on the present system, which stands condemned by its acknowledged failure, and by the verdict of a very large number of experienced officers.

UNITED STATES FISHERIES

Report of T. B. Ferguson, a Commissioner of Fisheries of Maryland, January 1881. (Hagerstown, Maryland: Bell and Co.)

THE figures of fish culture as we find them in the various reports of the American fishery commissioners are perfectly startling in their magnitude. In this report of Major Ferguson we are favoured with an account of the piscicultural work carried on in connection with the "Shad" (*Alosa sapidissima*), an excellent food fish, which is now being bred in millions at several places in the United States. A table of the numbers of these fish which have been brought to market, being the yield from the Potomac River only, shows that the catch in fifteen years, namely, from 1866 to 1880, amounted to 10,621,444 individual fishes. The averages captured in periods of five years were as follows:—

First five years	(1866-70)	870,109 single shad.
Second ,,	(1871-75)	874,114 ,,
Third ,,	(1876-80)	380,065 ,,

These figures are instructive. The shad fishery, as demonstrated by the number of fish marketed at Alexandria and Washington, seems to have culminated in 1873, when the numbers offered for sale were 1,142,629 individual fish. After that year the supply begins to fall off, till in 1878 the figures are reduced to 166,923 single shad. The fluctuations of various years can be accounted for in different ways to some extent, but as the Commissioner says: "We must recognise in these statements the inevitable result of successive years of over fishing; of disturbing the fish on their spawning beds; and of preventing them from reaching such beds." The ease with which all kinds of fish can be treated pisciculturally has been a really important discovery for the American people, because there has begun all over the United States a sensible, and in some instances a very marked, decline in the supply of nearly all kinds of fish, even the salmon—in that great depository of these fine fish, the Columbia River—are diminishing in numbers, consequent upon the incessant capture. It is gratifying therefore to learn from the present report that there need be no bounds put to the increase of our food fishes, and to be told that fishes inhabiting the salt water exclusively can be as readily propagated artificially, and increased to as unlimited an extent as the "anadromous fishes," with whose spawning habits we are more thoroughly acquainted. We have at home been accustomed to look with feelings of wonder on the hatching of a hundred thousand salmon eggs as if that were a sort of miracle, but the record of the shad hatching operations given by Major T. B. Ferguson sinks into insignificance anything that has yet been accomplished in the way of "pisciculture" in Great Britain. In a period of some fifty days, upwards of twenty million eggs of the shad were obtained, and over eighteen millions of these eggs came to life as fish! These young fish were all safely deposited in waters where they had a good chance of growing to maturity and ultimately contributing to the national commissariat. It would seem to be a leading idea of those who have the largest say in the regulation of the American fisheries that it is better to multiply the fish by means of what is known as pisciculture than to restrict in any way the operations of the fishermen during the legitimate fishing seasons; so long as the work of the pisciculturists can keep pace with the work of the fishermen there can be no objection to the occasional glutting of the markets with such wholesome food.

We learn from a portion of Mr. Ferguson's report that there are on the Atlantic Coast of the United States nine fishes belonging to the herring tribe. Although no special hatching station has yet been established for the propagation of the Clupedia, it has been ascertained that like other fish they can be operated upon "pisciculturally," and many hundred thousand eggs of these fish have been hatched by way of experiment, the newly developed fry being at once restored to the water. Some varieties of this fish are of great commercial importance, and will doubtless at once attract attention, as being capable of being bred in millions on the artificial system. Indeed the Menhaden has been already so operated upon with great success.

Some interesting details are given by Major Ferguson of the piscicultural work done in connection with the carp and landlocked salmon. Great interest has been taken in carp culture throughout the United States. The original stock of carp from which all supplies have been obtained, were imported by Prof. Baird, of the Smithsonian Institution, some years since from the best ponds of Europe—chiefly from Germany; the "leather" or scaleless variety is held in most esteem. It appears that the carp has been acclimatised in America with great success, increasing in bulk year by year with almost phenomenal rapidity, the ratio of growth being truly remarkable. This is accounted for by the great abundance of their natural food which these fishes find in American waters, and by that comparative mildness of the weather, which affords them a much longer feeding season than they have in their native country. During their spawning season, great pains are taken to procure the eggs of these fish; they are, however, allowed to spawn naturally, but the twigs and blades of grass on which the ova found a resting place were at once removed to ponds which had been prepared for their reception, where the eggs speedily came to life. The carp have been extensively distributed over the States of America in small numbers—from ten to twenty pairs only being given to applicants, but the fish has multiplied exceedingly, so that in the course of another year or two the carp will be quite a common fish throughout the United States. "This fish," says the report, "is so admirably adapted for domestic purposes, that every one in the State who has even a small pond, such as is usually devoted to the collection of ice, should prepare it for rearing the carp, which, being largely a vegetable feeder, can be raised at very little expense, and can be utilised for the consumption of the waste of the kitchen garden." It is interesting to know that a war of extermination had to be entered upon to get rid of the kingfishers: these feathered robbers having played havoc among the young fish. The "golden ide," from its conspicuously brilliant colour, became the chief prey of the birds.

Among the miscellaneous fishery work mentioned in the present report is the hatching of 200,000 eggs of the Californian salmon in floating boxes in the north branch of the Potomac, near its source. The fry were protected till the umbilical sac was absorbed, when they were liberated to shift for themselves; it will be interesting to know how these fish progress. So far as it could be carried, the experiment was greatly lauded by experts in fish culture. The reporter is in favour of movable hatching boxes, being convinced that "by means of such apparatus our streams can be much better stocked with Salmonidæ, than by the systems hitherto pursued of developing the eggs in hatching houses and transferring the young fish thence."

The remainder of the report is devoted to a long treatise on the oyster, and an account of experiments on oyster culture, which we have not space to discuss in the present number.

OUR BOOK SHELF

Wanderings South and East. By Walter Coote. Maps and Illustrations. (London: Sampson Low and Co., 1882.)

Pioneering in the Far East, and Journeyings to California in 1849, *and the White Sea in* 1878. By Ludwig Verner Helms. Illustrations. (London: Allen and Co., 1882.)

ALTHOUGH these two volumes cover a very wide field, neither of them can be said to break on new ground. Mr. Coote does not profess to be much more than a tourist, but as he tells the story of his wanderings pleasantly, and touched at a few places concerning which our information is scanty, he may be held to have sufficient excuse for bringing the record of his journey before the public. He spent some time in the Australian Colonies and Fiji, and visited Norfolk Island. His wanderings further embraced the Hawaiian Islands, the New Hebrides, the Banks and Torres Islands, the Santa Cruz and Solomon Islands, New Caledonia and the Loyalty Group. China and Japan, and Central and South America were also embraced in his extensive tour. Mr. Coote is a good observer, and the information he gives concerning what he saw in the less frequented islands, the New Hebrides, the Santa Cruz, Solomon and Loyalty Islands, is a welcome addition to existing knowledge. He is chiefly interested in the people, habits, houses, implements, and weapons, and therefore the ethnologist may find something in his volume that will be of service. The illustrations are good, and the volume as a whole is extremely pleasant reading.

Mr. Helms is an old traveller, and most of his volume takes us back about thirty years ago. He spent considerable time in Bali and Borneo, where he took a prominent part in the events connected with Rajah Brooke; visited Cambodia and Siam, China and Japan, and spent some little time in California during the height of the gold fever. He brings together much curious and interesting information about Bali and Borneo, especially at the time of his sojourn, the condition of the people, their manners and customs, the state of trade, &c. He gives a very vivid description of an instance of suttee which he witnessed. His account of what he saw in California is interesting, and he finishes off with the record of a visit to the White Sea, in connection with some mining operations. Altogether his book is quite worth reading.

Hölzel's Geographische Charakter-Bilder für Schule und Haus. Herausgegeben unter Pädagogischer und Wissenschaftlicher Leitung, Von Dr. Josef Chavanne, K. v. Haardt, V. Prausek, Prof. V. Marilaun, Dr. Fried. Simony, Dr. Fr. Toula, Dr. K. Zehden, &c. (Vienna: Edward Hölzel, 1882.)

WE have already referred, in connection with Hirt's Geographische Bildertafeln, to the comprehensive idea of geography entertained in Germany, and the admirable methods adapted for infusing into the teaching of the subject as much of reality as possible. For enabling the pupil to realise the features about which he reads in his text-books, we have never seen anything to equal the Charakter-Bilder which are being issued by Hölzel of Vienna, and edited by a large staff of some of the best teachers. These pictures are on a very large scale, are coloured by the oleographic process, and have all the appearance of good oil-paintings. Each picture is devoted to one subject, and measures something like 2½ feet by 2 feet. The aim is evidently to illustrate the leading features of the earth's surface, and bring before the pupil the main characteristics of the different countries. Nine of these pictures have already been published; their subjects are the Ortler Region, the Shoshone Cañons and Waterfalls of North America, the Gulf of Pozzuoli, the Sahara Desert, the Bernese Oberland (a double picture), the Rotomahana Region of New Zealand, the Sierra Nevada, the Eastern Border of the Anahuac Plateau. Thus, it will be seen, the subjects are very varied. To each picture there is a separate explanatory text, entering with somewhat minute detail into the characteristics of the region illustrated, its topographical features, geology, biology, &c.; the text being accompanied with wood engravings still further to help in the understanding of the subject. We need scarcely point out what an important help these pictures and their text must be in the study of geography, nor how admirably calculated they are to lead children to interest themselves in the subject. To the household library they would be an important addition, and even those who have long left school might turn them over with pleasure and profit. We should like to see them brought within the reach of English schools.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Researches on the Division of the Chlorophyll-Granules and upon the Occurrence of Hypochlorin in the Cyanophyceæ and Bacillariaceæ

I, IN the year 1881, made a considerable series of examinations of the division of the chlorophyll-granules of phanerogamous and cryptogamous plants, and upon the occurrence of Pringsheim's hypochlorin in the lower algæ, especially in the order Bacillariaceæ and Cyanophyceæ (Phycochromaceæ). The investigations are in detail described in my paper, "A chlorophyll és a növényi sejtmag morphologiájához. Irta Schaarschmidt Gyula. Rajzokkal egy photogrammon. Kolozsvárt, K. Papp Miklós örököseinél, 1881. 56 pp. 16°" (Contributions to the Morphology of the Chlorophyll and Vegetable Nucleus. With photograms. Kolozsvár, 1881, &c.), which is published in the Hungarian language. I take the liberty of briefly communicating the chief results, by way of insuring my priority.

I. The division of the chlorophyll-granules was discovered by Carl Nägeli in the year 1844. After him Milde, Wigand, Hofmeister, Rosanoff, Sachs, Kny, Strasburger, Velten, Haberlandt, Mikosch found that the chlorophyll-granules multiply by division in the lower and the higher plants. According to these authors, the granules are divided by a constriction in the middle; the green colouring-matter retires to the poles; consequently the protoplasmatic isthmus between the daughter-granules is colourless. The new daughter-granules increase in size, until they become as large as their parent-granules. When detached, each divides again, and the process is repeated. But the process is, according to my observations not so simple. We find here an example of division that is very similar to the multiplication of the nucleus described and drawn by Hanstein, Strasburger, &c. The green colouring-matter retires before the division to the two poles of the oval-shaped granules, and in the middle a colourless band is thereby formed. In this state will be seen with powerful lenses (2000–3000 lin. magn.), and by careful preparation with alcoh. abs. and tinction of anilin, that in the protoplasmatic isthmus small threads (filaments) are formed. The extremity of the threads is immediately fixed in the protoplasmatic matter of the granules. If we examine the double granules, which are now lying detached at a little distance (united solidly by the threads), we see the threads between the daughter-granules expanded. This figure reminds us of the state of nucleus division called "cell-tun" (*Zell-Tonne*) by Strasburger. The new daughter-granules separate further and further; the threads are more and more extended, until the intervening space equals that occupied by two to three granules. During this time the inner portions, as they extend, develop more and more of the circle, until each becomes a perfect hemisphere. The daughter-granules are separated by the growth itself and by accident, and the division is determined by the dilaceration of the threads. The young granules increase in size, and acquire their normal figure. After the division, there may be found upon the granules a few protoplasmatic hyalin cilia, divided in groups. These cilia are the remainder of the divisional threads. All these cilia spring from points where dark spots are seen upon the surface of the living granules. The compressed granules of Hartwegia, of Fern-Prothallia, of Vallisneria, and Elodea offer most favourable opportunities for ascertaining the manner of division. This singular process is repeated again and again, so that the older granules are compressed, and a filament is formed, which elongates more and more rapidly as the granules increase in number. Sometimes the filament may be ramified. This continued multiplication by division has its limits; the protoplasmatic bearer (the matter of the granule, which carries the colouring substance) changes its appearance, and contains starch-granules, which soon become numerous. The whole process cannot, of course, be seen in the same granule, but in some, dividing granules may be observed in one stage, and in others in another. In such a manner (though the process is not so clear) divides the endochrome of the Bacillariaceæ, as I have studied it, in *Himantidium pectinale.* That is the manner of division certainly most common. The second mode of multiplication by division is more simple. The granules are divided by a constriction, and separate into single granules; the daughter-granules become detached after they have reached their full form and size. No cilia or threads, only a small number two to three (not six to eight) are formed by the division in the isthmus between the half-granules. This division is a reduced form of the former, that is, the direct division without cilia; the former is the indirect division with cilia. The direct division I have studied in all higher and lower green plants in all seasons of the year. The second form, the direct division, is seen especially in the cells of Vaucheria and Chara. These changes in the division of chlorophyll-granules of which we speak, can only be observed with a considerable magnifying power (2000–3000 lin. mag.), that is the cause why Mikosch agrees with the other authors mentioned in disclaiming the notion of threads of the true mode of division. I ascertained these changes in March of the year 1880, and described them in a short notice in the *Magyar Növénytani Lapok* (Hungarian Journal of Botany, edited by Prof. Dr. Kanitz Kolosvár (vol. iv. pp. 32-43).

II. Prof. Pringsheim,[1] after ascertaining the occurrence of hypochlorin in all higher chlorophyllous plants, and in many green algæ, speaks in his paper, with reference to the Bacillariaceæ, "Sie fehlt (the hypochlorin) dagegen bei den nicht chlorophyll grünen Gewächsen; also bei den Phycochromaceen, Diatomeen, Phæosporeen. . . . Wenigstens konnte ich sie bisher in den genannten Pflanzengruppen noch nicht sicher nachweisen und nur Spuren derselben ist es mir geglückt, in manchen Entwickelungsstadien einiger *Diatomeen aufzufinden.*" I have, with the use of diluted muriatic acid, proved the occurrence of hypochlorin in all the Bacillariaceæ and Cyanophyceæ (Phycochromaceæ) investigated. The experiment succeeded best with *Calothrix scopulorum.* The hypochlorin was seen in all these plants in the typical form of brown scales or brown drops.

SCHAARSCHMIDT GYULA

Botanical Institute of the Royal Hungarian University,
Kolosvár (Hungary), August 3

Mimicry in the "Plume Moths"

I HAVE not seen in any entomological work an attempt to explain the well-known peculiar character of the wings of the "Plume Moths" (*Pterophori*). They depart so thoroughly from the rest of the Lepidoptera in having the wings cleft into so-called feathery "plumes" (although retaining the microscopic scales characteristic of their order), that we may be certain so marked a type must have been evolved along definite lines and for specific reasons. One species (*Aglistes Bennetii*) may be regarded as the first stage in the differentiation of these insects; and from this species we have successive modifications in the number of "plumes" up to *Alucita polydactyla*, where the ordinary wings are split up into no fewer than twenty-four.

I have long thought this wing-peculiarity is due to *mimicry*, the objects mimicked being the down or *pappi* of thistles and other composite plants. The commonest of the "Plume Moths," perhaps, is the "Large White Plume" (*Pterophorus pentadactylus*), and all entomologists are acquainted with its peculiar *drifting* mode of flight, exactly resembling that in which a thistle plume is blown by the wind. The other day I followed what I took to be a drifting thistle-plume, for the sake of seeing what species it belonged to, and found it to be a specimen of this species of moth, so remarkably similar do the two objects appear when in motion. If the intention of the "plume-moths" is to mimic the *pappi* of winged-seeds, we can understand why these insects do not fold the wings to the body when at rest, but seem to display them to the utmost instead.

The fact that (according to Stainton), out of about twenty species of *Pterophori*, the larvæ of which have their food-plant given, no fewer than ten feed on composite plants, or plants bearing plumed seeds, indicate that the resemblance of the winged insects to pappi must also be protective to females when depositing their eggs on plants which produce down, as well as when they are flying. It would be interesting to compare the different kinds of thistle and other down with the appearance of the various species of "plume-moths" which thus appear to mimic them.

J. E. TAYLOR

Ipswich Museum, September 5

NOTE ON SOROCHE (MOUNTAIN SICKNESS) IN THE ANDES

THE effects of diminished atmospheric pressure on the human economy seem to vary so much with different individuals that a few facts of personal experience may be of some interest to those who have attended to the subject. During a somewhat prolonged acquaintance with mountain travelling, I had never felt any of the symptoms described as characteristic of mountain sickness. The only effect of rarified air that I had been able to verify was that an equal amount of mechanical effect produced at a great height necessitates a greater effort, so that climbing or other muscular effort causes, *cæteris paribus*, more sense of fatigue. Being in Peru in the month of April last, I was about to avail myself, with a friend, of the opportunity afforded by the reopening for traffic of the Oroya railway, and to spend a few days at Chicla, the present terminus of that remarkable work. The height of Chicla above the sea is 12,200 feet, and we were assured by several residents in Lima that we should infallibly suffer from the *soroche*, the local name for mountain sickness in Spanish America. Not having ever experienced the slightest inconvenience at heights considerably exceeding that limit in the Alps, I treated these warnings with some derision, and in truth they had passed from my mind on the evening when I arrived at Chicla. I may say at once that neither there nor anywhere else have I experienced any of the symptoms of mountain sickness by day, or while up and moving about after dark. On the evening of our arrival, after a frugal supper we retired to bed about eleven o'clock. Soon after falling asleep, I awoke with a severe headache, which continued throughout the night, allowing only a few short and broken snatches of sleep, but which passed away soon after I rose somewhat before sunrise. On comparing notes with my friend, I found that he also had suffered from headache during the night; but as he is somewhat subject to that affection, he had not attributed it to any special cause, whereas with me it is most unusual.

The following day was spent in botanising on the steep slopes upon either side of the valley at Chicla, and as I was quite free from any inconvenient sensation, I attributed the headache of the previous night to some accidental cause rather than to diminished pressure. On the second night, going to bed about the same hour, I again awoke with a headache more severe than that of the previous night, and was altogether unable to sleep for the rest of that night. Some two or three hours after midnight I was suddenly seized with retching of the stomach, but, perhaps because my light dinner was fully digested, no further effect followed.

We had arranged for the succeeding day to ride to the

---

[1] Ueber Lichtwirkung und chlorophyllfunction in der Pflanze Jahrb. f. wiss. Bot. xii., 1851. Heft iii. p. 296.

summit of the pass where a tunnel for the railway was nearly completed before the troubled state of the country put a stop to the work. Owing to delays, usual in that part of the world, we were unable to start until ten o'clock. Partly on that account, and partly because snow had fallen during the night towards the summit of the pass, we resolved to halt at a point about 14,300 feet above the sea, and devote a couple of hours to the very interesting vegetation of that region. Although the path was not steep in that part, my horse, a spirited animal, already showed symptoms of distress, panting for breath and pausing at every few yards; but neither I nor my companion felt the slightest inconvenience during the day. On my return I fully expected some renewal of the symptoms of the preceding night, but to my surprise I slept perfectly on that as well as the succeeding night, as did also my companion. It seemed as if the ascent to a higher level and the return to Chicla had the effect of acclimatising us.

I should mention that on the first two nights we both noticed one further symptom of derangement of the functions in the extreme turbidity of the secretion from the kidneys, but this as well as the others disappeared on the third night. I failed to detect any disturbance of the respiration or the circulation, although my attention was specially directed to these which are the ordinary, but not invariable, symptoms of mountain sickness.

J. BALL

DREDGING IN THE NORWEGIAN FJORDS

BEFORE leaving this enchanting spot (Lervik on the island of Stordoe near Bergen) where, in company with Mr. A. G. Bourne, I have spent the month of August, I send a few hurried lines to give an outline of the results which a month's dredging and microscopising have yielded. Lervik was introduced to me by the Rev. Alfred Norman, who two years since found here, at a depth of 100 fathoms in the Hardanger Fjord (about five miles from Lervik haven), that very remarkable Polyzoan mollusc, Rhabdopleura. Mr. Norman originally discovered this organism off the Shetlands, and it has since been described from specimens observed in the Lofoten Islands by Prof. G. O. Sars, who was able to give a more complete account of it than had been possible for Prof. Allman, who described and named Mr. Norman's Shetland specimens preserved in alcohol.

During ten days of my stay here I have had the great advantage of the company of Mr. Norman, whose knowledge of dredging operations and of the northern marine fauna is unrivalled. My object has been to make a further study of Rhabdopleura upon fresh and living examples, and in this I have been successful. At first we found Rhabdopleura only at great depths attached to recently dead pieces of the beautiful coral, *Lophohelia prolifera*. But subsequently we have been able to dredge it and bring it in for study within an hour, having discovered it in water of only 25 fathoms depth at the mouth of the harbour where it occurs in the form of creeping colonies upon *Ascidia mentula*, and on dead shells. A body-cavity, tentacular skeleton, male reproductive organs, and various facts as to the mode of growth, gemination, and development of the polypides, are the new features which these specimens have so far brought to light, whilst they have also served to confirm in many important respects the description given by G. O. Sars.

Our next most important "find" has been a very interesting green-coloured Gephyrean, in all probability identical with the *Hamingia arctica* of Koren and Danielsen, known hitherto only by one spirit-specimen, described last year by the Norwegian zoologists, and by a second dredged here two years since by Mr. Norman, but as yet unnoticed. The published specimen appears to have lost its frontal process or appendage, which was perfect in the one dredged by us. The aspect of the complete worm is precisely that of a green Thalassema, from which, however, it differs most importantly in the absence of genital setæ, and in the structure of the cloacal nephridia, as also in the number and structure of the oviducts. Hamingia is also remarkable, as is *Thalassema neptuni* (which I obtained last year in quantity on the south coast of Devon) for having in its perivisceral fluid a large number of corpuscles deeply impregnated with Hæmoglobin, which give to the fluid a blood-red colour.

The special feature of the sea-bottom at depths of 100 fathoms and upwards, in these Norwegian Fjords, is the abundance of corals and Alcyonians. Nothing can exceed the delicate beauty of the white branches of *Lophohelia prolifera*, with which our "tangles" are always filled. *Amphihelia ramea* is nearly as frequent. *Allopora Norvegica*, a fine example of the Stylasteridæ made famous by Prof. Moseley, is also very abundant. But the most splendid of these coral forms is the *Paragorgia arborea*, of which we have taken a stem as thick as a man's arm, its branches spreading over three feet, and all (when living) of a perfectly uniform rose colour, as though modelled in wax of that tint. Allied forms—*Paramuricia placomus* and *Primnoa lepadifera*—are not uncommon, the latter affecting a bright salmon colour. The soft parts of nearly all these forms have yet to be studied in detail, and the preservation of samples in the approved reagents has been our special care.

Antedon Sarsii, *Rhizocrinus lofotensis*, *Neomenia carinata*, and *Chætoderma nitidulum* are amongst the scarce animals of exceptional interest which we have had the good fortune to dredge. On the other hand, *Terebratulina caput-serpentis* and *Waldheimia cranium* are very abundant in only thirty fathoms, and Mr. Bourne has commenced an investigation of their structure which has been hitherto neglected, probably on account of the marvellous completeness of the account given by Hancock of *Waldheimia Australis*, based though it was on the study of spirit-specimens. A first result is that Terebratulina is not monœcious, but males and females are distinct.

Amongst animals of common occurrence or of less interest from an anatomical point of view, we have taken the following, identified by Mr. Norman, who has himself a much longer list from this and other parts of the Norwegian coast. Of Echinoderms, *Psolus squamatus*, *Oligotrochus vitreus*, *Holothuria elegans*, *H. intestinalis*, *Echinocucumis typica*, *Echinus sphæra*, *E. Flemingii*, *Spatangus purpureus*, *Echinocyamus pusillus*, *Echinocardium ovatum*, *Goniaster Phrygianus*, *Porania pulvillus*, *Astrogonium granulare*, *Archaster Parelii*, *Luidia Sarsii*, *Solaster furcifer*, *Stychaster roseus*, *Cribella oculata*, *Asterias rubens*, *A. glacialis*, *Ophiopholis aculeata*, *Ophiocoma nigra*, *Ophioglypha lacertosa*, *O. albida*, *Ophioscolex purpurea*. Of larger Crustaceans, *Hyas coarctatus*, *Galathea tridentata*, *Munida Banfica*, *Hippolytus securifrons*, *Pandalus annulicornis*, *Pasaphæa Savignii*. Of Sponges there are a very large number which have never yet been examined; amongst those recognised were *Thenia Wyville-Thomsonii*, *Geodia norvegica*, *Thecaphora* (a "Porcupine" form), *Quassilina brevis*, *Asbestopluma* (a new genus of Norman), and other common forms. The Rhizopods include some very extraordinary and large forms, abundant *Haliphysema*, *Astrorhiza limicola*, many arenaceous species, and a black sausage-like organism attaining a length of one-third of an inch, the skin of the sausage, membranous with an emarginate aperture at one pole—the contents hyaline protoplasm with an immense number of large dark green granular corpusles embedded in it. Of the Nemertines and Chætopods, I will not venture to speak without library, and the list of mollusca would fill a whole column of NATURE. One word I would say in conclusion, namely, that were a real zoological station, similar to that of

Naples, to be established in Northern Europe, it would be difficult to find a spot so admirably fitted as Lervik, on account of the richness of its fauna, and especially in view of the fact that the deep-sea fauna is brought almost to the door by the peculiar condition of the fjords, dredging up to 400 or 500 fathoms being attainable a few miles up the Hardanger. E. RAY LANKESTER

Lervik, Stordoe, near Bergen, Norway, August 27

SCIENTIFIC RESULTS OF THE "JEANNETTE" EXPEDITION

THE last number (August 26) of *Der Naturforscher* contains a first attempt to lay down the scientific results of this expedition, in a paper by Herr H. Wichmann, based on the reports of Messrs. Melville and Danenhauer, and of the naturalist of the expedition, Mr. Newcomb. It is known that after having passed, on August 31, the wintering station of the *Vega*, the *Jeannette* sailed north, towards Wrangel's Land. But on September 5, when twenty miles north-east of Herald Island, she was frozen in, and during twenty-one months remained so, "the play of winds and currents." However drifted in different directions, she still advanced during all this time towards the north-west. The first wintering was north of Wrangel Land, which last proved to be a large island, and not a part of an Arctic continent as had been presumed. The precious observations on auroræ and magnetism which were made during the winter (about 2000 measurements) are unhappily lost, as well as extensive collections of birds and of deep-sea fauna. The depth of the ocean in these regions was everywhere very small—thirty fathoms on an average, with a maximum of sixty and a minimum of seventeen fathoms. The bottom was usually a blue ooze, with a few shells and sometimes stones, which seemed to be of meteoric origin.

The ship still drifted towards the north-west, and on May 17 a small island, called Jeannette Island, was sighted in 76° 47′ 28″ N. lat. and 159° 20′ 45″ E. long. It was a rocky hill, covered with snow, situated on the eastern flank of a high mountain. Two days later another island was discovered towards the west, and an expedition under Mr. Melville reached it, with many difficulties, and landed on it on June 3, 1881. It was called Henrietta Island, and is situated under 77° 8′ N. lat. and 157° 43′ E. long.; it is rocky, and 2500 to 3000 feet high; the rocks are covered with nests of birds, but the vegetation is very poor, consisting of lichens and mosses, and of one species of phanerogam; all the island was covered with a sheet of ice and snow 50 to 100 feet thick, and a mighty glacier reached the sea on the north coast. As is known, on June 13, under 77° 30′ N. lat., and 155° E. long., the *Jeannette* was lost, the depth of the sea being there 38 fathoms. The crew, divided in three parties, went south, but ten days later they perceived that, owing to the drift of the ice, they had still advanced 27 miles north-west, being under 77° 42′ N. lat. That was the highest latitude reached by the expedition. On July 9 they perceived land, and after a hard journey, reached it at a promontory they called Cape Emma (76° 38′ N. lat., 148° 20′ E. lat.). This island, which received the name of Bennett, is a high mass of basalt, covered with glaciers; the island was crossed by a party, after two days' travel, and the north coast proved to be more hospitable than the south; it has several valleys covered with grass, where reindeer bones and drift-wood were found; lignite was discovered on the south coast, and it is said that it would be quite useful for steamers. Dr. Ambler here collected fossils, as well as many amethysts and opals, but they were lost. The gulls were so numerous and so tame that hundreds of them were killed with sticks; the tides were regular, but very small, the level changing only two and three feet. The sea was free of ice in the west and south, and even in the north-west a "water-sky" was seen, so that M. Danenhauer supposes that Bennett Island would be a good starting-place for future arctic expeditions. It was only on August 30 that the expedition discovered the first traces of men on the Faddeyeff Islands; and its further advance towards the delta of the Lena is well known. The scientific results of the *Jeannette* expedition cannot be yet completely appreciated, observes Herr Wichmann, but the note-books and surveys of its members having been preserved, as well as a good part of the collections, it is to be expected that they will contribute to a great extent to increase our knowledge of this part of the Arctic Ocean. The discovery of three new islands confirms the statements of Sannirikoff, who stated he saw land from the Faddeyeff Islands, and renders probable the existence of a whole archipelago in that part of the ocean. The exploration of the fauna and flora of the New Siberian Islands, which never was done before during the summer, promises interesting results. The problematical *polynias*, which stopped the advance of the sledge parties of Hedenström, Wrangel, and Anjou are not due to some warm currents, such having not been noticed during the temperature-observations of the *Jeannette*; they are simple openings in the ice, such as are observed elsewhere. Finally, the search expedition must give most important corrections to the maps of the Siberian coast between the Olenek and the Yana rivers, which has not been visited for sixty years; the observations of the American expedition will correct many of the observations of Lieut. Anjou. We may add to these expectations of Herr Wichmann that, as the Arctic law that "each polar expedition safely reaches the points which were sighted by the preceding one," will probably be true also for the North Siberian Seas, we must soon expect new and important discoveries in that direction, now that the way was opened to explorers of those parts of the Arctic seas.

NOTES

WE regret to learn that M. Joseph Liouville, the editor of the *Journal de Mathematiques*, died in Paris on September 7 at the age of seventy-six years. For some time back he had retired from his editorship and appointed M. Resal, a member of the Institute, as his successor. M. Liouville was born in St. Omer, admitted to the Polytechnic School in 1825, and appointed in 1829 an engineer of the Ponts-et-Chaussées. He soon resigned in order to devote himself entirely to the study of pure mathematics. He was elected in 1839 a member of the section of geometry in the Paris Academy. In 1848 he was sent by the electors of the Meurthe to the National Assembly, where he supported Arago's policy. In 1862 he was appointed a member of the Bureaux des Longitudes.

A MONUMENT to Becquerel, the French electrician, will be inaugurated this month at Chatillon.

DR. LEMSTRÖM, of Helsingfors, begins to-morrow a series of measurements of terrestrial currents, which measurements will be continued the 1st and 15th of each month. They will be made on two telegraphic lines, one of which, between Torneo and Helsingfors, runs north and south, and the other, between Mariehann, on the Åland islands, and Kexholm, runs west and east.

THE Council of the Parkes Museum have just acquired new premises in Margaret Street, Cavendish Square, to which the museum is to be removed from University College as soon as the alterations and additions, which are now being made under the direction of Mr. Mark H. Judge, A.R.I.B.A., are completed. The new museum will consist of a central hall, suitable for meetings and lectures, a library and corridors, all lighted from the top and well suited for exhibition purposes. The meetings and lectures on sanitary and other matters connected with the health of the people, which were only occasional while the museum was at University College, will form a permanent feature of the institution when it is reopened in Margaret Street. It is expected that the museum will be reopened before Christmas, in the meantime communications may be addressed to the Secretary and Curator, Mr. Mark H. Judge, at 8, Park Place Villas, Paddington, W.

In the Report of the Executive Committee to the General Committee of the Great International Fisheries Exhibition at the meeting on the 7th inst., it was stated that since the date of the last meeting of the General Committee the arrangements for the preparation of the Gardens of the Royal Horticultural Society for the reception of the Exhibition have been greatly advanced. The plans of the proposed buildings have been determined upon, and the details of construction are so arranged as to be economical and effective, and can with ease be extended in the event of more space being required. The total amount of space at present provided for by the existing and new buildings, will amount to 220,300 square feet. A sub-committee has been appointed to superintend the construction of tanks and aquaria, and all the necessary arrangements for the piscicultural department. Since the date of the last meeting the Committee have received highly encouraging notices of adhesion from several additional governments and colonies, one of the latest received being a highly satisfactory telegram, through the Foreign Office, from the Imperial Government of China. From several parts of France also the process of oyster cultivation, carried to great perfection in that country, will be well represented; and the exhibits promised from Hungary, Italy, and Germany, are such as the Committee feel will be in the highest degree interesting, whilst from Norway and Sweden, the Netherlands, and other countries, including the Chilian Republic, which enjoy the advantage of local committees sanctioned by the governments, the collective exhibits sent will of course approach perfection. The International Meteorological Committee, who recently held their Annual Conference at Copenhagen, agreed to forward to the Exhibition from their respective countries representations of the system of forecasting the weather. From the colonies, for the most part, very satisfactory replies have been received, and official arrangements have been organised in nearly all the colonies connected in any way with the fishing interest. In the list of special prizes the Committee have made large and important additions, notably the prize of 600*l*. for the best life boat, and have received from private individuals donations to cover a certain amount of the expenditure thus involved. Among the more scientific subjects for prize essays are the following:—The Natural History of Commercial Sea Fishes of Great Britain and Ireland, with special reference to such parts of their natural history as bear upon their production and commercial use. This would include natural history, food, habits, and localities fish frequent at different seasons, and artificial propagation—100*l*. (This will not include Salmonidæ). On Improved Facilities for the Capture, Economic Transmission and Distribution of Sea Fishes, 100*l*. On Improved Fishery Harbour Accommodation for Great Britain and Ireland, indicating the localities most in need of such Harbours, the general principles on which they should be constructed, and the Policy the State should adopt in aiding and encouraging Harbour Accommodation for fishing purposes, 100*l*. The best Appliances and Methods of Breaking the Force of the Sea at the Entrance to Harbours and elsewhere, 100*l*. On the Food of Fishes both in Fresh and Salt Water, accompanied by illustrations and Preparations, 50*l*. On the Introduction and Acclimatisation of Foreign Fish, 25*l*. On the Propagation of Fresh-water Fish, excluding Salmonidæ, 25*l*. On the Propagation of the Salmonidæ, 25*l*. On Salmon Disease: its Cause and Prevention, 25*l*. On Oyster Culture, 25*l*. On the best Method which has been practically tested of cultivating Crustacea, 25*l*.

Thanks mainly to the exertions of Baron Miclucho Maclay, the Biological Station at Sydney has now been completed. It consists of a six-roomed cottage erected on the jutting point of land between Watson's Bay and Camp Cove. The building is of wood on a stone foundation with an iron roof. In the stone basement part of the space has been walled in, and when more funds are available other portions will be partitioned off as rooms for the carrying on of rough dissections and other operations which cannot well be carried on in the rooms above, and for the storage of bottles, spirits of wine, chemicals, dredges, nets, and other collecting gear. The rooms above are six in number, in three suites of two rooms each, so that biologists wishing to live close to their work may use one room as a bed-room, and the other as a laboratory. The laboratories are 15 feet by 12, with a lofty ceiling; the windows are large, with an easterly aspect, and large skylights permit of the entry of a certain amount of additional light from above. The partitions between the rooms are double—the interspace being filled with sawdust to deaden noises. A verandah 6 feet in depth runs round the whole building. Considerable additions require to be made to the appliances of the institution before it can be regarded as efficiently equipped for the purposes for which it is intended. Aquaria and other appliances are still wanting; and it is very desirable that a house should be erected for the accommodation of a paid caretaker, who should attend to the aquaria, dredge for specimens, and in other ways assist the biologists working in the stations. The Royal Society of New South Wales has granted the Biological Station the sum of 25*l*. from its funds, and it is expected that this grant will be repeated from year to year. The Royal Society of Victoria have also promised an annual sum, and the Australian Biological Association will also probably be in a position to grant an annual sum to the Sydney Station. Further subscriptions, however, are still required, and will be thankfully received by the treasurer. The station is open to biologists of the male sex, irrespective of nationality, on payment of a small weekly sum to meet the expenses of service, &c.

We find some notes on the recent meeting of the American Association at Montreal, in the New York *Nation*. This year the well-known geologist, Principal Dawson, was the presiding officer. The attendance was large, especially from the United States. Among the men of note from across the ocean the most conspicuous are Dr. W. B. Carpenter, and the Rev. Dr. Haughton, of Trinity College, Dublin. Besides these may be mentioned Dr. Valdemar Kovaleski, Professor of Geology in Moscow, Dr. Kœnig, of Paris, the investigator in sound, and Mr. Fitzgerald of Dublin. The most liberal hospitalities of a prosperous city were extended to the guests from a distance. The retiring president, Prof. Brush, of New Haven, selected for his address a theme in his own department, and treated it like a master. His discourse was a good illustration of the tendency of scientific men to limit their work to a special line, and to avoid general observations upon the fields which they have not personally tilled. According to the *Nation*, there was nobody in the Congress, and not more than one person in all the land, so competent as he to review the history of American mineralogy, and to point out the requisites for the further prosecution of the science. A marked feature of American minerals, said Mr. Brush, is the grand scale upon which crystallisation has taken place—common mica in sheets a yard across, feldspar where a single cleavage plane measured ten feet, prisms of beryl four feet long—and so in general much larger crystals than those obtained from European localities. Another noteworthy fact is the occurrence, in abundance, of some of the rarer elements as constituents of the minerals found. For example, among the rare earths, glucina, zirconia, &c., lithium occurs in our lithia micas, and spodumene containing from 5 to 8 per cent. of lithia, occurs by the ton in at least one locality. Among rare metals which form metallic acids, columbium, the first metal new to science discovered in America, is found from Maine to Georgia. Many other examples were given, including the rare metal tellurium, which is found in Colorado in one locality, where masses of twenty-five pounds have been taken out. Yet only a small portion of the United States has been thoroughly explored, and we are far behind Europe in the variety of minerals obtained from our mines. If trained mineralogists would oftener go into the field, and if wealthy amateurs would aid in exploring American localities as freely as they engage in importing costly specimens from Europe, they would do much to foster science. In the afternoon of Wednesday the introductory addresses were given by heads of the nine sections into which of late the Association has been divided. The address in the Mathematical and Astronomical Section was read for its author, Prof. Harkness, of the Naval Observatory, on the Transits of Venus. It was an historical and, to a moderate extent, a critical review of what has been hitherto done in the observations of such transits, with particular reference to the results attained in 1874 and to those which are to be expected in 1882. Dr. H. C. Bolton, of Trinity College, gave a review of the recent work of the Chemical Section, and then took for his theme the history of chemical literature, especially in its early aspects. In physics the speaker was Prof. Mendenhall, of Columbus, O., who was formerly in Japan, and he made an address on the methods to be pursued in teaching physics in colleges. Prof. W. P. Trowbridge, of Columbia College, in the Section of Mechanics, made a strong plea for the promotion of experiments in mechanics, in close connection with theoretical studies. He dwelt upon the extraordinary demands now made by the public on engineers, and gave many illustrations of what experiment has done, and instances of what it may do in the future, to determine problems of profound importance In the Biological Section, Dr. W. H. Dall, of Washington, gave an account of what has been accomplished in this country towards a knowledge of the biology of the mòlluscs. In the related Section of Histology and Microscopy Prof. Tuttle, of Columbus, O., questioned the propriety of a special microscopical section, and in the section last to be named, the Anthropological, a paper by Dr. Daniel Wilson, of Montreal, was read on some of the physical characteristics of certain native tribes in Canada. In the Physical Section the most remarkable paper was that of Prof. Rowland, describing the new gratings which he has made at the Johns Hopkins University for the study of the solar spectrum. He exhibited the results obtained by these gratings in photographs of the spectrum, which, it is stated, far surpass any that have hitherto been made. The generous and informal hospitality of Montreal received grateful recognition on all sides. Excursions had been arranged to Ottowa and Quebec, private houses were freely opened to guests; the Local Committee on one evening, Principal Dawson on another, and the Art Association on a third, offered evening entertainments. Public lectures were promised by Dr. Carpenter on Deep-Sea Soundings, and by Prof. A. Melville Bell on Visible Speech. The number of persons enrolled as in attendance was more than eight hundred.

IT is stated that the curiosities and other articles brought home in the screw survey ship *Alert*, Capt. Maclear, now lying at Sheerness, have been securely packed, and are to be forwarded to the Hydrographer's Department at the Admiralty, where they will be examined, and then probably distributed among the National Museums.

ON Saturday, September 9, the Members of the Essex Naturalists' Field Club had a field-meeting at Grays, for the second time this season, for the purpose of visiting the "deneholes" in Hangman's Wood. As on the former occasion in June, arrangements had been made by Messrs. Brooks, Shoobred, and Co., of the Grays Chalk Quarries Company for the descent of the party into some of the holes, of which a very perfect one having six vaulted chambers was discovered, and was surveyed by Mr. T. V. Holmes, F.G.S. An ordinary meeting of the Club was held at the hotel in the evening, and some discussion as to the origin and age of these interesting prehistoric excavations took place. Mr. Henry Walker, Mr. Worthington Smith, and others, took part in the discussion, the president, Mr. R. Meldola, in conclusion, expressing his belief that much work would have to be done before the question could be in any way settled, and he suggested that the investigation should be taken up systematically by the Club.

THE Third Annual Cryptogamic Meeting of the Essex Field Club will be held on Saturday, September 23, in the Northern Section of Epping Forest, the head-quarters for the day being the "Crown Hotel," Loughton. At the evening meeting papers on cryptogamic botany will be read, and an exhibition of specimens will be held. Botanists wishing to attend should communicate with the Hon. Secretaries, Buckhurst Hill, Essex. This Club is rapidly developing into one of the most important local societies in the kingdom; its *Transactions*, of which part 6 is before us, have already attained formidable dimensions, and their contents are of solid value. In the new number we have papers on the "Origin and Distribution of British Flora," by Prof. Boulger; "On the Land and Freshwater Mollusca of Colchester District," by Mr. H. Laver; "The Galls of Essex," by Mr. E. A. Fitch; "The Mammalia of Essex," by Mr. H. Laver; A List of the Hymenomycetal Fungi of Epping Forest, by Dr. M. C. Cooke; besides the address by the president, Mr. Meldola, Journal of Proceedings, field meetings, &c.

WE have before us the *Proceedings* of several other local societies; in that of the Bristol Naturalists' we find papers on "The Age of the Wye," by Mr. C. Richardson; the Lepidoptera of the Bristol District, part v., by Mr. A. E. Hudd; the Fungi of the same district, by Mr. C. Bucknell, besides several papers on more general subjects. We are glad to meet with the *Transactions* of the Eastbourne Natural History Society in a more attractive and handy form than formerly; the number before us, for May, contains one or two papers on local subjects, though most of them are of a very general nature. The *Report and Transactions* of the Birmingham Natural History and Microscopical Society contains several good papers of a general character.

IN October Messrs. Longman and Co. will publish a Dictionary of Medicine, edited by Richard Quain, M.D., F.R.S. The editor has been engaged on this work for several years. He has, we are informed, received the assistance of a large number of the most eminent members of the medical profession, and others, who have contributed articles on subjects to which they have paid special attention. The work, it is stated, will furnish a complete record of the present state of medical science. It will be issued in one large volume containing nearly 1900 pp. medium octavo.

INTELLIGENCE received from the Austrian circumpolar observing party states that the *Pola* cast anchor in Marimus Bay, Jan Mayen, on July 13. In addition to the buildings brought in the ship, two more were erected from drift-wood, which was found in large quantities. There was little snow on the island, but much ice outside. The meteorological observations commenced on August 15 on the Beeren Mountain, at a height of 5000 feet. Two tablets stating the whereabouts of the expedition had been erected, one at Ekö, and the other in English Bay. The *Pola* left Jan Mayen on August 16.

SEVERAL shocks of earthquake have been felt at Panama recently; one on September 7 caused a great deal of damage, while on the 9th another shock seems to have done still more damage. Several towns in the interior seem also to have suffered, whilst the long-dormant volcanoes of Chiriqui are said to be active again.

THE example of the English Government has produced some effect on the French military aëronauts. Their captive balloons will be exhibited publicly for the first time in the great manœuvres of this year.

THE Academy of Aërostation will try on September 22 the system of aërial, panoramic photography, for which they have received a subvention from the City of Paris. This scientific experiment, which, it is expected, will bear interesting results, will take place on the occasion of the *fête* of the "Defence National," round the Lion of Belfort, at a very little distance from the Observatory.

IN the *Transactions* of the New Zealand Institute, vol. xv. (for 1881, published in 1882), Mr. W. M. Maskell, F.R.M.S., continues his valuable memoir on the *Coccidæ* of New Zealand, and describes interesting new forms. The descriptions appear to be clear, and the notes on economy full and serviceable. The figures are unfortunately rough, and in two instances where the males are delineated, are practically useless from this cause. This is unfortunate, because male *Cocci* are comparatively rare, and very much depends upon their careful delineation when discovered. We think no one would ever suspect the true position of the insect figured on Pl. xiv. Fig. 27, were it not for the surroundings.

WE have before us the *Sitzungsberichte und Abhandlungen der naturwissenschaftlichen Gesellschaft Isis in Dresden* for January–June, 1882. The publications of this old-established society seem to be scarcely so well-known in this country as they should be. The financial condition appears to be flourishing. There are few local societies in Germany that possess an invested capital of 250*l*. to 300*l*. We note, especially, the following papers contained in this part:—The Diamonds of the Royal Mineralogical Museum of Dresden, "crystallographische Untersucht," by A. Purgold; Results of observations at the meteorological station at Dresden, by Prof. S. A. Neubert; a paper on a fossil Pseudo-scorpion from the Carboniferous of Zwickau, by H. B. Geinitz; and another on fossil Cockroaches from the "Dyas" of Weissig, by Dr. Deichmüller, illustrated by a plate. There are also several botanical papers.

THE Swedish Government has decided, that from the beginning of next year no individual shall be employed on railways or on board ship in that country till his sight has previously been tested as to colour-blindness, by a method devised by Prof. Holmgren of Upsala.

WE have received a letter from a gentleman in Hong-kong, signing himself "Verax," referring to a note in our issue of June 1, on the subject of the projected Chinese telegraph line between Hong-kong and Canton, and the alleged refusal of the Colonial authorities to permit the landing of the cable across Victoria harbour on British territory. The facts as stated in our note he allows to be correct. But whatever the grounds—and "Verax" fails to show there are any substantial ones—for local opposition to the enterprise, we regard it as peculiarly unfortunate that any forward step of the Chinese should be retarded by the British authorities.

A MEMBER of the Russian Geographical Society, Mr. Poliakov, who with a few followers has been exploring the island of Saghalien, recently ceded by Japan to Russia, has just returned to St. Petersburg, having spent about a year in the island. He states that the greatest river, the Tymy, is navigable for vessels with sixteen feet draught for a distance of eight miles. This river is the only harbour on the island with the exception of Ruegda Bay on the north coast, but which is situated in a barren and unpopulated district. The flora and fauna were found to be the same as those of North Siberia. Judging from the antiquities and stone implements discovered, it is supposed that the island has been inhabited in prehistoric times, while other remains show that at one time large fisheries have been carried n here.

WE have on our table the following publications:—Ueber den Bau und das Wachtthums der Zellhäute, Dr. Ed. Strassburger (Fischer, Jena); Synthèse des Minéraux et des Roches, F. Fouque et Michel Levy (G. Masson); Elementary Botany, Henry Edmonds (Longman and Co.); Handbuch der Vergleichenden Anatomie, E. O. Schmidt (Fischer, Jena); Our Great Peril if war overtake us with our Fleet deficient in Number. Structure, and Armament, Admiral T. M. C. Symons, G.C.B. (W. Kent and Co.); The Economics of Fair Trade, W. R. Herkless (Wilson and McCormick); The Physiology and Pathology of the Blood, R. Norris, M.D. (Smith, Elder, and Co.); On Failure of Brain Power, Julius Althaus, M.D. (Longman and Co.); Benderloch: or Notes from the West Highlands, W. Anderson Smith (A. Gardner); Silurfossiler og Pressede Konglomerater I Bergensskifiene, Hans W. Reusch (Broggers, Kristiania); Meteorological Charts for the Ocean District adjacent to the Cape of Good Hope, Stationery Office; also Remarks explanatory of the foregoing; Catechism of Modern Elementary Chemistry, E. W. v. Volckxsom (Kegan Paul); Cameos from the Silverland, vol. ii., E. W. White (Van Voorst); Worms and Crustacea, Alpheus Hyatt (Green, Heath, and Co.); Micro-Fungi, Thomas Brittain (Heywood); Faith, the Life Root of Science, Philosophy, Ethics, and Religion, H. Griffith (Elliot Stock); Experimental Physiology, Richard Owen (Longmans); The Origin and Relations of the Carbon Minerals, Prof. Newberry; Tests of Incandescent Lamps for Fall of Resistance, &c., A. Jamieson; House Sanitation, G. H. Stanger, C.E. (C. John Steen, Wolverhampton); Induction, Willoughby Smith (Hayman Bros.); Hothouse Education, J. A. Digby (Stanford); Familiar Lessons on Food and Nutrition, Part I., T. Twining (Bogue); An Impromptu Ascent of Mont Blanc, W. H. Le Mesurier (Elliot Stock).

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, presented by Mr. W. Mason; a Rhesus Monkey (*Macacus erythræus* ♀) from India, presented by Mrs. H. C. Dawson; a Crested Porcupine (*Hystrix cristata*), a —— Spider (*Mygale*, sp. inc.), a Scorpion (*Scorpio*, sp. inc.) from West Africa, presented by Mr. G. H. Garrett; six Spanish Blue Magpies (*Cyanopolius cooki*), three Pleurodele Newts (*Pleurodeles walti*) from Spain, presented by Lord Lilford, F.Z.S.; a Greater Vasa Parrakeet (*Coracopsis vasa*) from Madagascar, presented by Major-General Hill; two Common Barn Owls (*Strix flammea*), British, presented by Dr. Boyd, F.Z.S.; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mrs. Freeman; six Sand Lizards (*Lacerta agilis*), European, presented by Herr J. Sehliger; two Pennsylvanian Mud Terrapins (*Cinosternon pennyslyvanicum*), two Adorned Terrapins (*Clemmys ornata*) from North America, presented by Mr. A. Forrer; a Ring-tailed Coati (*Nasua rufa*) from South America, deposited; a Leopard (*Felis pardus* ♂) from Africa, a Small-eared Fox (*Canis microtis* ♂) from the Upper Amazons, a Marsh Ichneumon (*Herpestes paludosus*) from South Africa, two Water Chevrotains (*Hyomoschus aquaticus*), an Erxleben's Monkey (*Cercopithecus erxlebeni*) from West Africa, a Red-faced Saki (*Brachyurus rubicundus* ♀) from the Upper Amazons, a Weeper Capuchin

(*Cebus fatuellus*) from Guiana, a Red-billed Toucan (*Ramphastos erythorhynchus*) from Cayenne, purchased; a Smooth Snake (*Coronella lævis*), European, received in exchange.

OUR ASTRONOMICAL COLUMN

Definitive Comet-orbits.—1. The fourth comet of 1874 (Coggia, April 17). Dr. Hepperger, of Vienna, has investigated the orbit of this comet from the whole extent of observation, founding his work upon 17 normals from 638 observed positions. He finds the orbit an ellipse with period of 13,708 years, and considers that his results exclude equally a parabola and any ellipse with a revolution shorter than 8000 years. The aphelion distance is 1144·9 (the earth's mean distance from the sun being taken as unity), at the descending node the radius-vector is 0·717, near the orbit of Venus, and at ascending node it is 11·734. Coggia's comet became visible to the naked eye at the beginning of June, and so continued until it was lost in these latitudes in the middle of July, when the tail had gradually increased to 23°.

2. Definitive elements have also been determined for the second comet of 1847, by M. Folke Engstrom of Lund. The comet was discovered by Colla at Parma, on May 7, and was last observed by the late Mr. Lassell at Starfield, Liverpool, on December 30, or over a period of nearly eight months. The orbit is chiefly remarkable for the large perihelion distance, 2·115, which has been exceeded in very few cases. The resulting elements are hyperbolic e = 1·0006549 So far as we know this is the only instance where the latest observations for position have been obtained with a reflector, the statement that has been more than once made that Halley's comet in 1836 was last observed by Sir John Herschel with his 20-feet reflector at Feldhausen, Cape Colony, being a mistake; the last observation was made by Lamont with the 11-inch refractor at Munich on May 17.

The Variable Star Algol.—The following are the Greenwich times of minima of Algol, occurring before 15h., during the last quarter of the present year, taking Prof. Winnecke's ephemeris as authority:—

	h.	m.		h.	m.		h.	m.
Oct. 14,	13	0	Nov. 9,	8	20	Dec. 16,	14	55
17,	9	49	26,	13	13	19,	11	44
20,	6	38	29,	10	2	22,	8	33
Nov. 3,	14	42	Dec. 2,	6	51	25,	5	22
6,	11	31						

The Motion of 61 Cygni.—The following formulæ appear to represent the observations of this remarkable system up to the present epoch within about their probable errors; P is the angle of position, D the distance:—

$$D \sin P = +\ 16''{\cdot}4657 + [8{\cdot}63013]\,(t - 1850{\cdot}0)$$
$$D \cos P = -\ \ 3{\cdot}6892 - [9{\cdot}27178]\,(t - 1850{\cdot}0).$$

Hence we find—

	Diff. R A.	Diff. Decl.	
1753·8	... +1″·2 ..	−1″·7	Bradley.
1778	... +1·9 ...	−0·2	Ch. Mayer.
	ΔP ($c - o$).	ΔD.	
1781·85	... +2°·4 ...	−0″·04	Herschel I.
1812·30	... −1·7 ...	−0·69	Bessel.
1822·26	... −0·1 ...	+0·14	Struve and Herschel II.
1830·84	... 0·0 ...	+0·01	Bessel.
1842·70	... −0·3 ...	−0·29	Dawes and Struve.
1856·37	... −0·1 ...	−0·29	Demb., Jacob, Secchi, 1854–1857.
1867·15	... 0·0 ...	−0·16	Knott, Demb., Duner, 1866–67.
1877·47	... 0·0 ...	0·00	Hall, Demb., Duner, 1875–79.
1881·45	... 0·0 ..	−0·01	Jedrzejewicz.

And for comparison with measures about this epoch:—

	P.	D.
1882·5	118°·50	20″·469
1883·5	119·08	20·476

The Comet of 1763.—The comet observed by Dunlop at Paramatta in 1833 has been referred to as affording an instance of near approach to the earth's orbit at both nodes; according to Dr. Hartwig's elements the distance at ascending node is 0·092, and at descending node 0·186. But a much more noticeable case is offered by the comet of 1763. In Burckhardt's ellipse we find the distance at ascending node 0·0315, and at descending node 0·0252, the time occupied in passing from node to node is 77·2 days.

THE EXCITABILITY OF PLANTS[1]

II.

THE complete knowledge we have gained from our study of the anther filaments of Centaurea of the mechanism of the excitable plant cell, can be applied to every other known example of irrito-contractility in the organs of plants, and particularly to that most remarkable of all such structures, the leaf of *Dionæa muscipula*. Although I described the structure of the leaf just eight years ago in this room, I will occupy a moment in repeating the description. The blade of the leaf is united on to the stalk by a little cylindrical joint. Here are two models, in one of which the leaf is represented in its closed state, in the other in which it is in its unexcited or open state. The leaf is everywhere contractile—that is, excitable by transmission, but not everywhere susceptible of direct excitation—or, in common language, sensitive. It is provided with special organs, of which we do not find the counterpart in any of the plants to which reference has been made, for the reception of external impressions—organs which, from their structure and position, can have no other function.

The action of the leaf, to which the plant owes its name, and by which it seizes its prey, is, in its general character, too well known to require description. In the shortest possible terms, it is the sudden change of the outer surface of each lobe of the leaf from convex to concave, and at the same time the crossing of the two series of marginal hairs, as the fingers cross when the hands are clasped. What I desire to show with respect to it is, that here also the agents are individual cells—that is, that the individual elements out of which the whole structure is built are the immediate agents in the production of the movement.

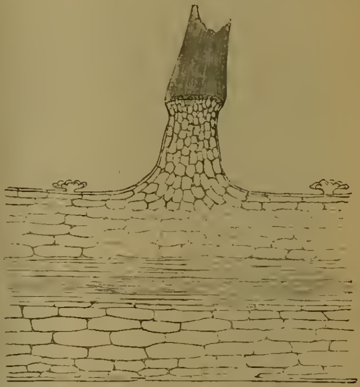


Fig. 6.—Transverse section of lobe of leaf of Dionæa comprising the root of a sensitive hair.

A cross-section of the leaf shows the following facts: If the section be made in the direction of the parallel fibro-vascular bundles which run out from the mid-rib nearly at right angles, and happen to include one of these bundles, it is seen that it consists of three parts, viz. the fibro-vascular bundle in the middle and equidistant from both borders; of the cylindrical cells of the parenchyma on either side, and of an external and internal epidermis. The external epidermis is smooth and glistening, and its cells possess thicker walls than those on the opposite surface.

---

[1] Lecture delivered at the Royal Institution June 9, 1882, by Prof. Burdon Sanderson, F.R.S. Continued from p. 356.

The most remarkable feature of the internal surface is, that it possesses the excitable hairs, three on each side, which in Dionæa are the starting-points of the excitatory process whenever it is stimulated by touch, as is normally the case when the leaf is visited by insects; for experiment shows that although the whole of the leaf can be excited either by pressure or by the passage of an induction current, the hairs exclusively are excited by touch. It is therefore of great interest to know their structure and their relation to the excitable cells of the parenchyma, with which they are in so remarkable a relation physiologically. In sections such as that which we will now project on the screen (Fig. 6), it is seen that each hair springs from a cushion which consists of minute nucleated cells inclosed by epidermis; and that if we follow this structure into the depth of the leaf, its central cells gradually become larger, until they are indistinguishable from those of the ordinary parenchyma of the leaf. By these cells it must be admitted that the endowment of excitability is possessed in a higher degree than by the ordinary cells of the parenchyma, so that for a moment one is tempted to assign to them functions corresponding to those of motor centres in animal structures (particularly in the heart). There is, however, no reason for attributing to them endowments which differ in kind from those we have already assigned to the excitable plant cell.

Fig. 8.

Fig. 7.

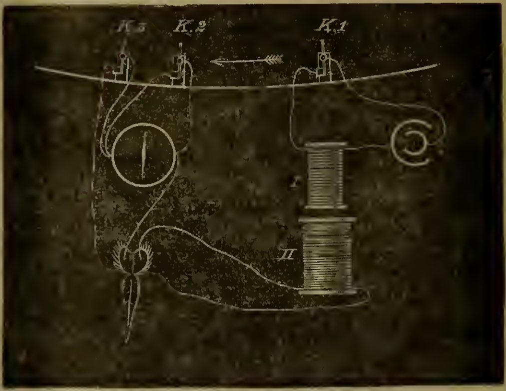


Fig. 9.

Fig. 7.—Dionæa leaf fixed so as to prevent its closing. (From a photograph). Fig. 8.—Diagram of ideal transverse section of lamina of leaf of Dionæa. The needle inclosed in a circle represents the electrometer which in the experiment described was substituted for the galvanometer. On the opposite side is shown the secondary coil of the inductorium. *m* is in connection with the capillary, *f* with the sulphuric acid of the electrometer. Fig. 9.—Diagram of the pendulum-rheotome. k_1, k_2, and k_3 are the keys referred to. I. and II. represent respectively the primary and secondary coils of the inductorium. The leaf galvanometer, battery, &c., will be easily recognised.

The fact that the excitable organs are exclusively on the internal surface of the lobe, suggests that although the parenchyma of the inside has apparently the same structure, it has not the same function as that of the outside—that is, that although the cells of the outer layers are just like those of the inner, they are either not excitable at all, or are so in a much less degree. In this way only can we account for the bending inwards of the lobe. In the unexcited state both layers are equally turgid; as the effect of excitation the internal layers become limp, the external remaining tense and distended.

I will now endeavour to illustrate the motions of the leaf by projecting them on the screen. Here are several leaves which have been prepared by attaching one of the lobes to a cork support; the other is free, but a very small concave mirror has been attached to its external surface near the margin. The image of the light which falls on the mirror is reflected on the wall behind me. In this way the slightest movement of the lobe is displayed. By this contrivance I wish to show you two things—first that a very appreciable time elapses between the excitation and the mechanical effect; and secondly, that when the leaf is subjected to a series of very gentle excitations, the effects accumulate until the leaf closes. This we hope to show by bringing down a camel hair pencil several times in succession on a sensitive hair, doing it so deftly that at the first touch the lobe will scarcely move at all. At each successive touch it will bend more than at the preceding one, until you see the lever suddenly rise, indicating that the leaf has closed. The purpose which I have in view is to demonstrate the contrast between the motion of the leaf and muscular contraction. A muscle in contracting acts as one organ—at once. The motion of the leaf is the result of the action of many hundred independent cells, all of which may act together, but may not. In either case they take a great deal longer to think about it; for during a period after excitation, which amounts at ordinary summer temperature to about a second, the leaf remains absolutely motionless.

And now we have to inquire what happens during this period of delay. There are two things which we may assume as certain without further proof, namely, first that something happens; for when I see a certain movement followed after a time invariably by another, I am quite sure that the chain between cause and effect is a continuous one, although the links may be invisible; and secondly, that this invisible change has its seat in the protoplasm of each of the excitable cells.

We have already seen that in muscle this latent state of excitation is not withhout its concomitant sign—the excitatory electrical disturbance, and I have now to show you that this, which is the sole physical characteristic of the excitatory process in animal tissues, manifests itself with equal constancy and under the same conditions in plants.

It will be unnecessary for my present purpose to enter into any details as to the nature of the electrical change; it will be sufficient to demonstrate with respect to it, first, that when observed under normal physiological conditions, its phenomena are always conformable to certain easily defined characters; secondly, that it culminates before any mechanical effect of excitation is observable, and consequently occupies, for the most part, the period of latent excitation already referred to; and thirdly, that it is transmitted with extreme rapidity from one lobe of the leaf to the opposite. Of these three propositions, it will be convenient to begin with the second. On the left-hand screen is projected the mercurial column of the capillary electrometer of Lippmann. The instrument which we use this evening is one of great sensibility, given me by my friend Prof. Lovèn of Stockholm. The capillary electrometer possesses a property which for our purpose is invaluable—that of responding instantaneously to electrical changes of extremely short duration. We cannot better illustrate this than by connecting the wires of the telephone with its terminals. If I press in the telephone plate I produce an instantaneous difference between the terminals in one direction, and in the opposite when I remove the pressure. You see how beautifully the mercurial column responds.

We now proceed to connect the terminals with the opposite sides of a leaf, so that by means of the mirror we can observe the moments at which the leaf begins to close and the first movement of the mercurial column, both being projected on the same screen. We shall see that the mercurial column responds (so to speak) long before the mirror. The difference of time will be about a second.

We now take another leaf which, with the plants of which it forms part, is contained in this little stove, at a temperature of about 32° C. Our object being to subject the leaf to a succession of excitations, the effects of which would of course be to determine its closure, we prevent this by placing a little beam of dry wood across it, and fixing the ends of the beam with plaster of Paris to the marginal hairs of each lobe. At the same time, wedges of plaster are introduced in the gap between the lobes at either end of the mid-rib. [The leaf so fixed was projected on the screen (Fig. 7).] This having been done, we can excite the leaf any number of times without its moving; and we know that we actually excite it by observing the same electrical effect which, in the first leaf experimented on, preceded the movement of the lobe.

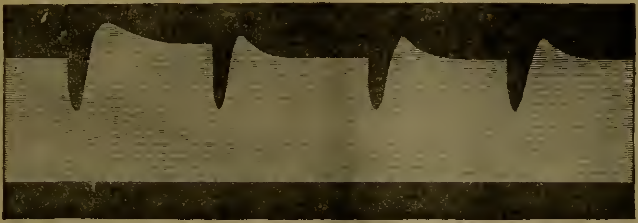


Fig. 10.—Copy of photograph of the excursions of the capillary electrometer as projected on a sensitive plate moving at the rate of ½ centimetre per second. The four "excitatory variations" shown were due to as many touches of a sensitive hair of the lobe opposite to that of which the opposite surfaces were connected with the terminals of the instrument.

And now I beg you to notice what the nature of the experiment is. The diagram (Fig. 8) shows the position of the electrodes by which the opposite surfaces are connected with the terminals of the electrometer. You will notice that they are applied to opposite points of the internal and external surfaces of the right lobe, and that the left lobe is excited. The experiment consists in this. By the electrodes near *r*, an induction shock passes through the right lobe. Apparently at the same moment the electrometer, which is in relation with the opposite lobe, responds. I say apparently, because in reality we know that the response does not begin until about 3-100th of a second later. We prove this by a mode of experimentation which is of too delicate a nature to be repeated here. I will explain the mode of action of the instrument used by a diagram (Fig. 9) which represents a pendulum in the act of swinging from left to right. As it does so, it opens in succession three keys, of which the first is interpolated in the primary circuit of the induction apparatus which serves to excite the leaf; the second breaks a derivation wire which short-circuits the electrodes, so that, so long as it is closed, no current passes to the galvanometer, which in this experiment takes the place of the electrometer, while the third breaks the galvanometric circuit. Consequently the opposite surfaces of the leaf are in communication with the galvanometer only between the opening of the second and third keys. These three keys can be placed at any desired distance from one another. If they are so placed that the galvanometer circuit is closed 1-100th of a second after excitation, and opened 3-100th of a second, and it is found that there is no effect, it is certain that the electrical disturbance does not begin at the part of the leaf which is interpolated between the galvanometer electrodes until at least 3-100th of a second after the excitation. If, on extending the period of closure to 4-100th of a second, the effect becomes observable, you are certain that the disturbance begins between three and four hundredths of a second after excitation.

By this method we have learnt, first, that even when the seat of excitation is as near as possible to the led-off spot, there is a measurable delay, and secondly, that its duration varies with the distance which the excitation effect has to travel so as to indicate that, in a warm stove, the rate of transmission is something like 200 millimeters per second. It is, consequently, comparable with the rate of transmission of the excitatory electrical disturbance in the heart of the frog.

And now I come to my last point, namely, that the electrical change has always the same character under the same conditions. You have already seen that when the method used is that which I have indicated, the electrical effect consists of two phases, in the first of which the external surface of the leaf becomes negative to the internal. I will now exhibit this in another way. Many present have probably seen in a recent number of NATURE reproductions of photographs recently taken by M. Marey, of the phases of the flight of birds. If the movement of a bird's wing can be photographed you will easily imagine that we can also obtain light-pictures of such a movement as that of the electrometer column. You have only to imagine a sensitive plate moving at a uniformly rapid rate taking the place of the screen, and you have as the result the photograph (Fig. 10) which I show. Here are the electrical effects of several successive excitations recorded by light with unerring exactitude. In each, the diphasic character is distinct, and you see that the first or negative phase lasts less than a second, but that the positive, of which the extent is much less, is so prolonged that before it has had time to subside it is cut off by another excitation.

It would have been gratifying to me, had it been possible, to exhibit to you other interesting facts relating to the excitatory process in our leaf. It has, I trust, been made clear to you that the *mechanism* of plant motion is entirely different from that of animal motion. But obvious and well marked as this difference is, it is nevertheless not essential, for it depends not on difference of quality between the fundamental chemical processes of plant and animal protoplasm, but merely on difference of rate or intensity. Both in the plant and in the animal, work springs out of the chemical transformation of material, but in the plant the process is relatively so slow that it must necessarily store up energy, not in the form of chemical compounds capable of producing work by their disintegration, but in the mechanical tension of elastic membranes. The plant cell uses its material *continually* in tightening springs which it has the power of letting off at any required moment by virtue of that wonderful property of excitability which we have been studying this evening. Animal contractile protoplasm, and particularly that of muscle, does work only when required, and in doing so, uses its material directly. That this difference, great as it is, is not essential, we may learn further from the consideration that in those slow motions of the growing parts of plants which form the subject of Mr. Darwin's book, "On the Movements of Plants," there is no such storage of energy in tension of elastic membrane, there being plenty of time for the immediate transformation of chemical into mechanical work.

I have now concluded all that I have to say about the way in which plants and animals respond to external influences. In this evening's lecture you have seen exemplified the general fact, applicable alike to the physiology of plant and animal, that whatever knowledge we possess has been gained by experiment. In speaking of Mimosa, I might have entertained you with the ingenious conjectures which were formed as to its mechanism at a time when it was thought that we could arrive at knowledge by reasoning backwards—that is, by inferring from the structure of living mechanism what its function is likely to be. In certain branches of physiology something has been learnt by this plan, but as regards our present investigation, almost nothing, nor indeed could anything have been learnt. Everywhere we find that nature's means are adapted to her ends, and the more perfectly, the better we know them. But, with rare exceptions, knowledge is got only by actually seeing her at work, for which purpose, if, as constantly happens, she uses concealment, we must tear off the veil, as you have seen this evening, by force. Have we the right to assume this aggressive attitude? Ought we not rather to maintain one of reverent contemplation—waiting till the truth comes to us?

I will not attempt to answer this question, for no thoughtful person ever asked it in earnest. Another question lies behind it, which is a deeper and a much older one. Is it worth while? Is the knowledge we seek worth having when we have got it? Notwithstanding that so recently even those who are least conversant with our work have been compelled to acknowledge the beauty and completeness of a life devoted to biological studies, still the question is pressed upon us every hour—How can you think of spending days in striving to unravel the mechanism of a leaf, when you know all the time that if there were no such thing as Dionæa, the world would not be less virtuous or less happy? That is a question which I willingly leave to those who put it. From their point of view it does not admit of an answer; from mine it does not require one. They must go on seeking for and finding virtue and happiness after their fashion; we must go on after ours, striving by patient continuance in earnest work, to learn year by year some new truth of nature, or to understand some old one better. In so doing, we believe that we also have our reward.

THE BRITISH ASSOCIATION

REPORTS

Third Report of the Committee appointed for the Purpose of Reporting on Fossil Polyzoa (Jurassic Species—British Area only). Drawn up by Mr. Vine (Secretary).—A partial examination of the Jurassic Polyzoa was made by Goldfuss (*Petrifacta Germaniæ*, 1826-33), but the author is not aware whether he had any English examples of the types described and figured by him. With the exception of the *Aulopora*, all the types are foreign, and he does not find any reference to British species in his text. In the "Geological Manual" of De la Beche, published in 1832, a list of species is given, but only two are named as found within the British area—*Cellipora orbiculata*, Goldfuss (=*Berenicea*, Lamouroux), and *Millepora straminea*, Phill. In the "Geology of York," ed. 1835, Phillips gave three species only—*M. straminea*, *Cellaria Smithii* (*Hippothoa* (?), Morris's Catalogue), Scarborough, and an undescribed *Retepora* (?). When, in 1843, Prof. Morris published his "Catalogue of British Fossils," there was a large increase of species, but many of these had not been thoroughly worked. In 1854, Jules Haime examined critically the whole of the Jurassic Polyzoa then known, and many English naturalists furnished him with material from their own cabinets so as to enable him to correlate British and foreign types. Lamouroux, Defranc, Milne Edwards, Michelin, Blainville, and D'Orbigny have published descriptions of Jurassic species, and a list of these, so far as possible, will be given at the end of this report. Prof. D. Braun, by the publication of his paper on species found in the neighbourhood of Metz, added materially to our knowledge of French Jurassic types, and later foreign authors, Dumortier Waagen and others, have increased the number of described species. Since the publication of Haime's work, much valuable material has been accumulating in the cabinets of collectors, and Mr. Vine willingly draw up a monograph if desired to do so. In the meantime he offers, in the following report, a rather compact analysis of genera and species known by name or otherwise to the palæontologist.

Classification.—Haime's arrangements of the Jurassic Polyzoa is very simple; all his species, excepting two, are placed in one family, the *Tubuliporidæ*. In the "Crag Polyzoa," 1859, Prof. Busk gave a synopsis of the "Cyclostomata," arranged in eight family groups, which were made to include several Mesozoic types. This arrangement, with a slight alteration, was followed by Smitt, Busk to some extent accepting the modification for the arrangement of recent Cyclostomata in his later work ("Brit. Mus. Cat.," pt. iii., 1875). The Rev. Thomas Hincks ("Brit. Marine Polyzoa," 1880) disallows the family arrangement of Busk in so far as it relates to British species. .The *Tubuliporidæ*, Hincks, include, in part, three of the families of Busk. In this report Mr. Vine follows Hincks as far as he is able to do so, as many of the Jurassic species may be included in the family *Tubuliporidæ* as now described. It will, however, in the present state of our knowledge at least, be impossible to arrange the species stratigraphically, as many, having the same type of cell, range from the Lias upwards. As far as the author is able to do so, he gives the range of the species, beginning, of course, with the lowest strata.

CLASS POLYZOA. Sub-order *Cyclostomata*, Busk. Fam. I. *Crisidæ*, Busk.—No fossils belonging to this family are at present known to have existed in the Jurassic epoch.

FAM. II. 1880. *Tubuliporidæ*, Hincks.—*Zoarium* entirely adherent, or more or less free and erect, multiform, often linear, or flabellate, or lobate, sometimes cylindrical. *Zoœcia* tubular, disposed in contiguous series or in single lines. *Oœcium*, an inflation of the surface of the zoarium at certain points, or a modified cell" (vol. i. p. 424).

1825. *Stomatopora*, Bronn. 1821. *Alecto*, Lamx.; 1826, *Aulopora* (pars), Goldf.—The Reporter has already done partial justice to the uniserial *Stomatopora*, found in the Palæozoic rocks of this and other countries. He has again studied the species described by James Hall, Prof. Nicholson, and himself, and he cannot, at present, detect any generic character in the species that may be used by the systematic palæontologist to separate the Palæozoic from the Mesozoic types. He must, therefore, regard the *Stomatoporæ* of the two epochs as one, though the sequence is broken in the Palæozoic—no species having as yet, he believes, been recorded from the Carboniferous series of this or any other country.

In our modern classification (Hincks) we have a sub-genus, *Proboscina*, which links together the genera *Stomatopora* and *Tubulipora*. Haime's second genus is also called *Proboscina*, but there seems to me to be a great difference between the recent and fossil species. The type of the recent sub-genus *Stomatopora incrassata*, Smitt, is a very peculiar species as regards the cells, and he knows of no Jurassic type that can compare with it.

Terebellaria. Lamouroux.—"A fossil, dendroid polypary, composed of cylindrical scattered branches, spirally twisted from left to right or from right to left indifferently; pores prominent, almost tubular, numerous, disposed quincuncially, and more or less inclined according to their position with the spires." Lamouroux says the genus should be placed after the *Millepores* and before the *Spiroporæ*, remarking "that the *Spiroporæ* have the cells or the pores projecting as in *Terebellaria*, but that this character is observable only in well-preserved specimens. When the prominent part of the spire has been worn by attrition, it looks like a narrow riband wound round the branch." The fossils which ordinarily pass for species of *Terebellaria* in the cabinets of collectors are a very curious group that may be more closely studied. Mr. Vine's studies are made from specimens from the Cornbrash, and Bradford Clay of Bradford and Stanton, Wilts, and it is from this locality that the School of Mines specimens were obtained. To properly master the details of colonial growth, it will be necessary to isolate a single colony. The one furnished by Haime as a specimen of a young colony on stone shows a tapering proximal point, gradually widening by the addition of cells, till a certain fan-like shape is arrived at. A similar growth to this is found in young colonies of *Diastopora*. If superficially examined, it will be seen that the cells are peculiarly arranged, beautifully punctured, with an orifice sometimes circular, at other times semi circular, and sometimes the cell characters of portions of the colony bear a resemblance to *Bidiastopora ramosissima* of D'Orbigny. A complete and critical examination of the type will show that any fragment of stone or shell is sufficient to form the nucleus of a colony. It begins with a primary cell and then enlarges in a spiral direction, but to what extent the riband-like growth would be carried without a check I am unable to say. In another direction a similar colony will be developed, the distal cells of which will ultimately meet and coalesce, both colonies striking out in fresh directions till met by another check, the growth not always being in an upward direction. The dendroid character of species is perfectly accidental.

Genus *Diastopora*, Lamx. Sy. with *Berenicea* (pars), Lamx. —Mr. Vine accepts this genus, in its wider sense, as defined by Hincks; yet he hardly thinks that it will be possible to include the whole of the foliaceous forms of the Jurassic period in one group. In this report he adheres to the arrangement of Busk, as he has done in his two papers on the Diastoporidæ, keeping the foliaceous types for distinct study. At the same time he is willing to admit that in getting rid of one difficulty in our grouping we open the door to admit others. Haime admits both the encrusting and foliaceous types, accepting the genus *Berenicea* for the encrusting, and *Diastopora* for simple-foliaceous and retiform species. Prof. Braun, in his Jurassic studies, separates the species *Diastopora foliacea* from the group, and establishes another, which he calls *Elea*, claiming for his type certain peculiarities which have been entirely overlooked by authors. It is very certain that the more closely we examine Jurassic Polyzoa and compare them with modern species of the genus *Diastopora*, the more divergent the types appear; and although we would rather accept a simple than an elaborate classification, still there are limits beyond which it is not wise to go.

BISERIAL DIASTOPORA, Milne Ed. *Mesenteripora*, Blainville; *Bidiastapora*, D'Orb; *Ditaxia*, Hagenow.—It is well that the encrusting and biserial *Diastopora* should be separated, but not widely so. In the choice of the above names he has selected the simplest—*Diastopores biserialares* of Milne Edwards—because it has the precedence of the *Bidiastopora* of D'Orb. Busk—in the "Crag Polyzoa" and in the "Brit. Mus. Cat." pt. iii —has chosen Blainville's name for this division of the group. Mr. Vine's chief objection to Blainville's term for the biserial species may be found in the diagnosis as given by Busk: "Cells in two layers, parted by a calcareous septum." In all the specimens figured in "Crag Polyzoa" (Plates xvii. Fig. 2; xviii. Fig. 4; and pl. xx. Fig. 2, pp. 109, 110) of *Mesenteripora meandrina* the transverse sections of the foliaceous zoarium are shown to have this septum very distinct. In many of Haime's figures where cross sections are given, the septa are also shown to be present. It seems to him, judging from the foliaceous specimens in my own cabinet, that this "calcareous septum" is only an apparent, and not a real character. If sections are made in a line with the cells, the only axis visible is that made by sections of the cell walls. In a cross section of the foliations there is an apparent septal division, but the more closely this is examined the less real will it be. The septal divisions of *D. scobinula*, *D. Terquemi*, and *D. cervicornis*, as given by Haime, show one, two, and three sections of cells on either side of the septal line; and specimens of Inferior Oolite species found in the neighbourhood of Cheltenham are in many respects of a similar character. As Mr. Vine has been able to examine only a very limited number of species, he would be glad to have more detailed information if students of our Oolitic Polyzoa will address their attention to this point. Meanwhile, by selecting the divisional name of Milne Edwards, he does not commit himself to any generic name dependent upon a questionable structural character.

1822. *Intricaria*, Defranc. 1830. *Cricopora*, Blainville. 1840. *Meliceritites*, Roemer. 1850. *Entalophora*, D'Orbigny. 1853. *Cricopora*, *Spiropora*, *Tubigera*, *Meliceritites*, *Laterotubigera*, *Entalophora*, D'Orb. Palæontology.—He has already vindicated by use and preference the retention of this genus for species of Palæozoic Polyzoa. He still retains the name for species of the genus very common in the Mesozoic rocks. He has also given the synonyms with their dates of genera intended to supersede Lamouroux's original term. It may be as well to define and limit the genus as applicable for the reception of Palæozoic, Mesozoic, and Cainozoic species. He is not aware that any recent species of Polyzoa can be included in the group.

FAM. III. HORNERIDÆ, Hincks.—This family contains only one genus, *Hornera*. There is no representative of the family, in Brit. Jurassic Rocks at least, and he is not aware of any recorded species of the genus in foreign Oolites. As the Rev. Thomas Hincks says that "the genus HORNERA is connected with TUBULIPORIDÆ, through *Idmonea*," to which it bears in many points a very close resemblance, in all probability early types of the genus, as defined by him, may yet be found in either the Jurassic or Cretaceous rocks. The *Siphodictyum*, of Lonsdale, is given as one of the synonyms of Hornera.

FAM. IV. LICHENOPORIDÆ.—This is the last family given by Hincks in which Jurassic Polyzoa can be placed. The genus *Lichenopora* of Defranc has also a number of synonyms, but as species of the genus are rare in the Oolites, we find only one recorded. Haime says the genus has not been represented until now, other than by Tertiary or Cretaceous fossils. In *Lichenopora Phillippsii*, derived from the Great Oolite of Hampton Cliff, the *zoarium* is disciform, very slightly elevated, and adherent only by the middle of its inferior face. The upper surface resembles a fungus, with unequally developed rays formed of a series of long zooecia, ordinarily doubled. The peristomes are polygonal, regular, and closely connected.

1835. *Neuropora*, Bronn.; *Chrysaora*, Lamx; *Filicaria*, D'Orb.—Species belonging to this genus are present in our British Oolites, in the Bradford Clay, and Cornbrash, but he has not been able to secure specimens to operate upon so as to study the internal characters. Dumortier describes several species from the Middle Lias, Haime describes three from the Great Oolite of Ranville and Hampton Cliffs, and Prof. Brann says that it extends from the Lower Lias onward into the White Jura and also into the Great Oolite of Ranville. It is also found about Metz. Through the kindness of Prof. Roemer of Breslau Mr. Vine had supplied to him the species of *Ceripora*, Goldfuss, which are referable to this genus, but the types differ in many particulars from our own species.

1834. *Heteropora*, Blainville.—We have now left one group of Oolitic Fossils which within the last few years have been more closely studied than any of the others, because of their supposed relationship with the Palæozoic *Monticulipora*. In his "Pertifactions of Germany," Goldfuss placed in the genus *Ceriopora* three species, which he describes and figures as containing large and small openings on the surface of the branches. These were *Ceriopora anomalopora*, *C. cryptopora*, and *C. dichotoma*, all of which were from the Mastricht beds of Astrupp or Nantes. In 1834 M. de Blainville separated these from the *Ceriopora* of Goldfuss, and established another one for their reception which he called *Heteropora*, assigning as essential structures the two sorts of openings, but giving very few details respecting the genus. After this Milne Edwards added to them *Millepora dumitosa* and *corigera*, Lamouroux. In his "Miocene Fossils of North America," Mr. Lonsdale complained of the inadequate description of Blainville as not having in it sufficient details "to enable an opinion to be formed of its complete characters, or of the nature of the minor openings." This error was to some extent rectified by Lonsdale, and we owe to him the merit of being the first author who clearly indicated upon sufficient grounds the real zoological position of the genus.

Report of the Committee on Electrical Standards.—Mr. Taylor had been engaged during the past year in determining the effect of the annealing of wires on the temperature co-efficient of their resistance. The experiments were not yet concluded, but so far they had shown that the effect of annealing was enormous, in some cases altering the temperature co-efficient by as much as 50 per cent. The Committee hoped that Lord Rayleigh would arrange a system for testing resistances at the Cavendish Laboratory. In connection with this report Lord Rayleigh made some remarks *On making Standard Resistance Coils equal to Multiples of an Original Unit Coil.* The usual method is to make a copy of the unit coil; by combining these, a coil of two units can be made, then of four, five, and so on. By this means the errors would accumulate. The method he proposed was simpler than this. Three coils each of three units resistance, placed in multiple arc, are equivalent to one unit, whilst in series the resistance amounts to nine units. This, with the addition of the original unit, makes a resistance of ten units. The observations should be made quickly after one another, and he explained an arrangement of mercury cups by which this was effected with rapidity.

Report of the Committee on Meteoric Dust, by Prof. Schuster.—The report referred to the work of M. Tissandier, who has found magnetic particles of iron in the dust gradually settling down in dry weather, or precipitated by rain or snow. These particles are of various shapes, but the most remarkable form is a spherical one, which conveys the obvious information that the particles at one time must have been in a state of fusion. These have been found in the snows on the slopes of Mont Blanc, at a height of nearly 9000 feet, in the sediment of rain collected at the observatory of Sainte Marie du Mont, and in the dust collected at different elevated positions. For an explanation of these magnetic spherules we are reduced to three alternatives. The particles may be of volcanic origin, they may have been fused in our terrestrial fires, or they may be meteoric. All the volcanic dust which the author has had at his disposal was carefully examined under the microscope, but its appearance was found to be altogether different from the supposed meteoric dust. Such also seems to be the conclusion arrived at by Tissandier. No iron spherules to the author's knowledge have been found in volcanic dust. The smoke issuing from the chimneys of our manufacturing towns contains iron particles similar in appearance to those to which Tissandier ascribes a meteoric origin. That some of these particles are found very far from any terrestrial sources which can produce them, would not perhaps tell conclusively against their terrestrial origin, but chemical analysis seems to settle the point. The iron particles issuing from our chimneys contain neither nickel nor cobalt, while these metals were found by Tissandier to exist in the microscopic magnetic particles found in rain-water collected at the observatory of Sainte Marie du Mont. We are, therefore, driven to ascribe a cosmic origin of these particles. During the last year the author has examined microscopically small iron particles from [the sand near the great pyramids, from the desert of Rajpootana, and from the Nile mud near the village of Sohag. The sand from the pyramids contains an appreciable quantity of magnetic particles. The great part of these particles are angular, and doubtless are due to the *débris* of magnetic rocks; but here and there spheres are found exactly like those described by Tissandier, and about the same diameter, that is 0·2 to 0·1 mm. The Rajpootana sands are not yet completely investigated, but as yet there has been no appearance of metallic iron. The author then passes on to consider the *débris* left behind in our atmosphere by the passage through it of shooting-stars. Tissandier has examined the dust found on meteors, and has found that it resembles in appearance the magnetic particles found in other places. The question arises, how is it that the red hot sparks from the meteors do not get oxidised, and the author pointed out that at high elevations the proprotion of oxygen in the atmosphere is very small, at a height of 100 kilometres being about 4 per cent. of the whole, supposing the temperature the same throughout the atmosphere. He also drew attention to the fact that a line in the spectrum of the aurora has not been recognised as belonging to any known substance, and from his experience in observing the spectra of oxygen and nitrogen under very various conditions, he felt convinced that it was not due to oxygen or nitrogen, but to some unknown gas of very small density. He pointed out that at a great height the density of this would only very slightly be diminished, and although of extremely small density, would nevertheless form by far the largest part of the atmosphere there. Consequently the meteoric sparks would only meet a very small proportion of oxygen. He mentioned that the spherules might be easily produced artificially by moving a file over a copper wire conveying a current of electricity. Collecting the sparks which fly off, these were found to contain a large proportion of spherules similar to those referred to meteoric origin, together with angular specimens such as had been found in some of the sands.

In *the Report of the Committee on Wind Pressure* it was stated that the maximum pressure on small plane surfaces had been ascertained to exceed 80 lbs. and even 90 lbs. per square foot. The pressure over any large area was still a matter of considerable uncertainty, but it was possible that the maximum pressure of 56 lbs. allowed by the Board of Trade might take effect over the whole of very exposed structures. The cases of wind and water pressure were somewhat analogous, at any rate with regard to the proper method of determining the relative exposure in various positions. In the latter case this might be done by a comparison of the readings of anenometers differently located.—Prof. W. C. Unwin remarked that some form of pressure guage of considerable delicacy was needed which could be applied to all parts of a roof. Mr. Barlow said that the Board of Trade rule was capable of being amended, and this no doubt would be done as soon as further knowledge was forthcoming; in the proposed Forth Bridge 3000 tons of steel would be employed for resisting wind pressure.

In the *Report of the Committee on Screw Guages* it was stated that there is at present no universally recognised form of screw-thread and no specified number of threads to the inch. For telegraphic and electrical apparatus some coherent and uniform system is much wanted. The report gave an account of the efforts made in Switzerland towards this end, and explained the screw guage finally adopted by that country. Much credit is due to Sir Joseph Whitworth for his important work in connection with the improvement of the system in England. The Committee asked to be re-appointed.

SECTION A—MATHEMATICAL AND PHYSICAL

On a Similarity between Magnetical and Meteorological Weather, by Balfour Stewart, M.A., L.L.D., F.R.S., Professor of Physics at the Owens College, Manchester.—It has been hitherto supposed that there is no traceable likeness between the magnetical and meteorological changes of the globe. The former have been imagined to be of a cosmical nature affecting all parts of the earth at the same moment of time, while the latter are well known to be of a local and progressive nature. As a matter of fact, all attempts to trace a likeness between simultaneous magnetical and meteorological phenomena have been without success.

There is however one class of magnetical phenomena that are of a progressive nature. I allude to the diurnal variations of the magnetic elements caused by the sun. Of these the solar-diurnal variation of the magnetic declination—that is to say the variation of the position of a freely suspended magnetic needle is that which has been most observed and best understood.

It has been noticed that the diurnal progress of this variation is not unlike that of atmospheric temperature; the hourly turning points in both being pretty nearly the same. Both phenomena too are regulated by the local time at the place of observation, and hence are of a progressive nature, travelling with the sun in his apparent course from east to west. Both phenomena too are subject to a well-marked annual fluctuation, the diurnal temperature range, for instance, or the difference between the indications of the maximum and the minimum thermometers being greater in summer than in winter; and in like manner the diurnal declination range or the difference between the east and the west positions of a suspended magnet being greater in summer than in winter. Finally both phenomena appear to be subject to the influence of something which may be called *weather*. Sometimes we have very hot days and cold dry nights in which the diurnal temperature range is very great, succeeded by close rainy weather in which the diurnal temperature oscillation is very small. In like manner we have sometimes a very large and at other times a comparatively small diurnal oscillation of the magnetic needle, so that it too is affected by the influence of magnetic weather. The question which I now wish to put is the following: Is there any connexion between these two weathers? between the temperature-range weather, and between declination-range weather, both defined as above?

Now there is I think preliminary evidence to show that both kinds of weather are due very greatly, if not altogether, to changes in the sun, a large declination-range, and a large temperature-range denoting an increase of solar power. There is also evidence that temperature-range weather once produced travels from west to east, taking probably on an average eight or nine days to cross the Atlantic.

There is also, I think, preliminary evidence that declination-range weather travels likewise from west to east, but quicker than temperature range weather, taking about two days to cross the Atlantic.

Now if this be true it might be expected that the declination-range weather of to-day should be found similar to the temperature-range weather six or seven days afterwards, so that by a study of the declination-range weather of to-day, we should be able with a certain measure of success to predict the temperature-range weather six or seven days afterwards.

I have here given the train of thought which led to this investigation, but, I ought to say that the results obtained do not depend upon the exact truth of every step of this train of reasoning.

This is in reality a matter of fact investigation undertaken with the view of ascertaining whether or not there is any recognisable connexion between these two weathers in Great Britain. The result obtained I may add was reported to the Solar Physics Committee, and by them communicated to the Royal Society.

In order to avoid as much as possible the influence of locality, I obtained through the kindness of the Meteorological Council the diurnal temperature ranges at Stonyhurst, Kew, and Falmouth for the years 1871 and 1872. I obtained likewise through the kindness of the Kew Committee, the diurnal ranges of magnetic declination at the Kew Observatory for the same two years, excluding disturbed observations. The temperature ranges discussed are therefore the means of those at the three observatories above mentioned, and still further to tone down or equalize individual fluctuations, the daily numbers exhibited are each the sum of four daily ranges the two before and the two after. Finally the object being to represent fluctuations of range rather than their absolute values, a daily series representing the mean of twenty-five daily numbers has been obtained. Each daily number is thus compared with the mean of twenty-five daily numbers both columns being symmetrically placed with regard to time and the differences whether positive or negative between the two columns is taken to represent temperature-range fluctuations.

A precisely similar course has been taken with respect to the Kew declination ranges.

By this means two years of daily numbers, sometimes positive and sometimes negative, representing temperature range weather, and two years of daily numbers sometimes positive and sometimes negative representing declination range weather, have been obtained. The next object is to compare the two series with one another.

Now when two series of waves representing elevations and depressions come together it is well known that we shall have the greatest result when the crests of the one series coincide with the crests of the other, and the smallest result, perhaps even none at all, when the crests of the one series coincide with the hollows of the other. This indeed is the well known explanation of musical beats.

Now if there be any marked likeness between the two weathers and if it be true that declination-range weather precedes temperature weather by six or seven days, the algebraic sum of the two sets of fluctuations representing these weathers will be greatest when the declination is pushed forward in point of time so that the declination fluctuations of to-day shall be summed up with the temperature fluctuation six or seven days after.

For suppose that the declination fluctuation of to-day is represented by a very large positive number; if the above theory be true, the temperature fluctuation six or seven days afterwards will be represented by a large positive number also, so that we shall have the addition of two large positive numbers, whereas, if we add the declination weather of to-day to the temperature weather of to-day it may chance that we are really adding a large positive to a large negative quantity in which case the result will be very small. It may also happen that this amount of precedence of declination-weather is greater at one season of the year than at another.

We have therefore to pursue a plan somewhat of the following nature. Take a month's temperature-weather say for the month of August and add to it a month's declination-weather, extending say from July 21st to August 21st, let the sum be 262. Here the declination month has been pushed forward 11 days. Next push it forward 12 days and let the sum be 273, then 13 days and let the sum be 276, next 14 days and let the sum be 270. It thus appears that the greatest sum is got by pushing the declination forward 13 days, and we may therefore presume that at this season of the year 13 days denotes the precedence of the declination weather.

On this principle the following table has been constructed.

Table showing by how many days the declination-range fluctuation precedes the corresponding temperature-range fluctuation.

Corresponding to middle of month.	Precedence of Declination. First year.	Second year.	Mean.
January	—	8	8
February	6	4	5
March	6	5	5·5
April	5	5	5
May	9	9	9
June	9	9	9
July	12	11	11·5
August	13	13	13
September	9	10	9·5
October	7	5	6
November	10	7	8·5
December	12	—	12

It thus appears from each year that the precedence of declination is smallest about the equinoxes, and greatest about the solstices, and it seems probable that were a considerable number of years so treated, more exact values would be obtained. Having thus determined the amount of precedence of the declination from month to month, the next point is to ascertain to what extent the two fluctuations when brought together in a manner regulated by this precedence show any distinct resemblance to each other. This has been done in a graphical representation which accompanies the report above-mentioned and I think I may say that there is a considerable likeness between the two curves, the one exhibiting temperature-range weather and the other declination-range weather so pushed forward.

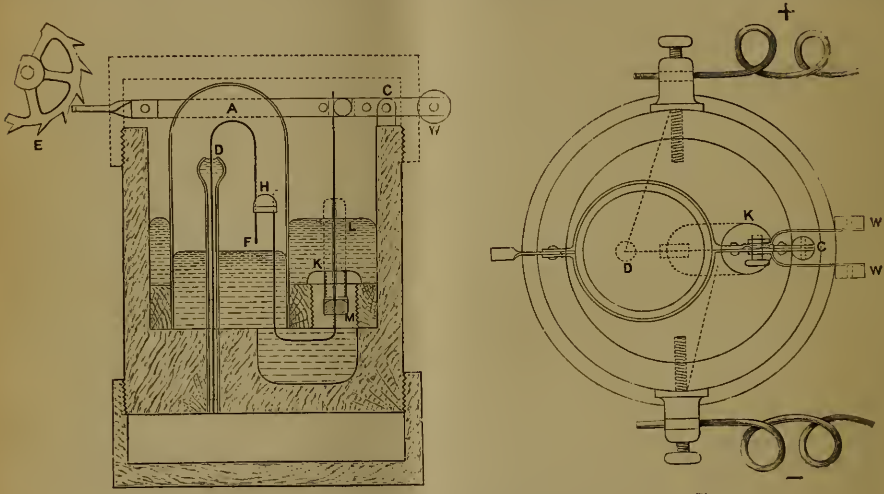
It would thus seem as if a comparison of magnetical and meteorological weather might be made a promising subject of inquiry besides being one which may perhaps lead to results of practical importance.

On a Supposed Connection between the Heights of Rivers and the number of Sunspots on the Sun, by Prof. Balfour Stewart, M.A., LL.D., F.R.S.—While a connection between the state of the sun's surface as regards spots, and the magnetic state of the earth, may be considered as well established, the fact of a connection between sunspots and terrestrial meteorology is still *sub judice*, and without attempting to assert the truth of such a connection, the following may perhaps be regarded as a slight contribution tending to throw light upon the subject. The heights of the rivers Elbe and Seine have already been examined by Fritz, who reported in favour of such a connection as would make a great height correspond to a large number of sunspots, and all that I have done has been to treat the evidence in a somewhat different manner. I divide each sun period without regard to its exact length into twelve portions, and put together the recorded river heights, corresponding in time to similar portions of consecutive sun-periods. I find by this means residual differences from the average, representing the same law whether we take the whole, or either half of all the recorded observations, and whether we take the Elbe or the Seine. This law is that there is a maximum of river height about the time of maximum sun-spots, and another subsidiary maximum about the time of minimum sunspots. It is of interest to know whether the same behaviour is followed by the River Nile. Through the kindness of General Stone Pacha, and through the Science and Art Department, South Kensington, information has been obtained about this river. This information shows us that the Nile agrees with the European rivers in exhibiting a maximum about the times of maximum sunspots and a subsidiary maximum about the time of minimum sunspots, only the subsidiary maximum is greater than for the European rivers already named. It also appears that the date of maximum height of the Nile is latest on these years for which the yearly height is greatest. Now the present year is, perhaps, not very far removed from a solar maximum, and I am thus induced to think that the Nile may this year be somewhat late in attaining its maximum rise.

Contact Makers of Delicate Action, by Prof. H. S. Hele Shaw.—The author has been engaged in designing a speed indicator in which it is essential to have the uniform motion of a revolving disk. This disk is subject to varying resistance, so that for driving it, clockwork, even though powerful and expensive, could scarcely be depended upon. It therefore seemed best to employ an electro-magnet acting on a ratchet wheel and controlled by a clock. This clock for the purpose might then be a common one, with lever escapement. Upon enquiry there appeared to be no contact maker at once, absolutely reliable, suitable for continuous use, and at the same time sufficiently delicate in its action.

In an instrument of this kind for completing circuit it is necessary to ensure such a close approach of the surfaces forming the opposite poles as practically amounts to absolute contact. With small differences of potential and without previous contact, the exact distances across which the current will flow appears to be at present unknown. According to Prof. Guthrie the terminals of 50 or 60 grove cells may be brought to within 1-1000th of an inch without any indication of the passage of a current. Prof. Tyndall says that a battery of more than 1000 cells is required to cause a spark at 1-1000th of an inch, and Prof. Sylvanus Thompson mentions 1-10,000th of an inch as the distance. To ascertain the quantity exactly, appears impossible without the use of an instrument of such refinement as Whitworth's millionth measuring machine, a modification of which might be very appropriately employed for the purpose. The distance no doubt is extremely small, and the consequent difficulty in the way of ensuring electrical contact when the opposite poles are the surfaces of two solids, seems to merit a brief consideration.

The ways in which two such surfaces are brought together may for convenience be divided into (1) a relative motion of the two terminal surfaces, normal to both; (2) a motion tangential to both; (3) a motion compounded of these two. The first mode is very common with rapid contact makers, such for instance of those with electric bells and telegraphic transmitters, but these require an appreciable amount of force to work them. That contact makers of this kind are not suitable with delicate clocks is the testimony of every clockmaker to whom the author has spoken One of these instruments of very delicate construction required the weight of nearly one gram to ensure electrical contact, and then could not be entirely relied upon. There is no doubt that when two surfaces of solids touch only lightly the area of contact is exceedingly small. This area may be made to increase by increasing the pressure with which they are brought into contact. The conditions of the problem under consideration do not admit of this being done to any appreciable extent. Thus, even when chemical compounds are prevented from forming on the surfaces, dust and particles floating in the air are liable to become deposited between them, and render contact uncertain.



Sectional Elevation. Plan.

Electrical Contact Maker (full size).

For these reasons contact of the second kind which is known as rubbing or sliding contact has been largely adopted. This action may be made perfectly reliable, and is suitable where the motion is not rapid as for instance with switches and commutators. But considerable energy may be absorbed in overcoming friction. Those clockmakers who employ it, appear to do so only for large clocks. The third method has, as far as the author is aware, been adopted in only one way, though in that way with eminent success. A contact maker of this kind is used by Mr. Hargreaves of Leeds, who has had it at work for fifteen years. A metal roller with rounded edge runs upon and between two metal rails of circular section, thus making contact between them. Contact is broken when the roller passes over a gap or joint to another pair of rails. When the roller is moving along the rails, there is a slight rubbing action, by reason of its resting between them. This is almost certain to produce electrical contact, which is even found to occur without failure when the whole is covered with dust. The metal employed is gold, which with a weak current, is found to last much better than even platinum. With a strong current the metal oxidises, and moreover, though working admirably with a heavy pendulum, the resistance is too great for a delicate escapement to overcome.

The use of a liquid terminal with which the the other terminal (being solid) is brought into contact obviates most of the foregoing difficulties. Of all liquids mercury is the only one which can be practically employed. There are two objections to its use which have hitherto prevented its being used for more than temporary and experimental purposes:—

1. The fact that it readily combines with oxygen on the passage of an electric spark.

2. The difficulty of rendering a contact maker of this kind portable.

The author has endeavoured to overcome the first of these by causing contact to be made in a gas which has no action on the mercury. The way in which this is done is as follows: A short glass tube closed at its upper end (such as an inverted test tube) is filled with mercury, and inverted in a vessel of mercury. The mercury is then partially displaced by hydrogen gas. A very light bent lever working on a pivot is connected with a platinum wire, which passes through the mercury into the gaseous space. It there makes contact between the mercury below, and a smaller quantity in an insulated capsule within the tube. The lever is worked from the outside by mere contact with the escapement wheel of an ordinary clock, which owing to its extreme sensitiveness is quite sufficient to do this. The positive and negative poles of the terminals are connected respectively with the mercury in the capsule and that in the vessel. It is evident that although the lever is always in electrical contact with the mercury in the vessel, the circuit is only completed when it is brought into contact with that in the capsule.

Various experiments have been made with this instrument, and the result has been completely satisfactory. With a battery of fifteen Grove cells the surface of the mercury was brighter at the end of half an hour than at the beginning of the experiment, although a much more brilliant spark was visible than when contact was made in air. After three weeks of intermittent working for periods of sometimes as much as twelve hours but with weaker batteries, the mercury remained quite clean.

The present form of the instrument is shown in the annexed figure. The general action is similar to the one already described A, being the gaseous space, D, the capsule of mercury, E, the escapement wheel. The chief improvements to be noted are :—

1. Contact is made and broken at F instead of at D, thus preventing sensible loss by volatilization from the small quantity of mercury in the capsule. The wire D F is insulated from the bent lever by the glass junction at H.

2. Portability is secured by having a plug, K, shown in dotted lines, which can be screwed down and a gland L, by means of which the wire can be packed by an india rubber washer, M. The lever and balance weights, W W, are made to go within the lid which can be taken off the bottom and screwed on to the top (as shown by the dotted lines). This keeps in any loose mercury above the plug.

3. The lever is so arranged that contact is only of momentary duration, a point of no little importance in connection with the constancy of the battery.

SECTION C—GEOLOGY

On the Geology of the Channel Tunnel, by Prof. W. Boyd Dawkins, F.R.S.—He laid special stress on the fact that the line of faults both on the English and French coast are small, neither of them have throws of more than 38 feet, and even this magnitude is rare, he therefore considers the chances of the older porous rocks being thrown by them is well nigh impossible. He considers, however, that in some cases this fault acts as ducts conveying water downwards, and he ascribes to one of these faults the well-known springs on Abbot's Cliff, known as the "Lydden Spout." 1. The lower beds of the chalk marl and the lower part of the grey chalk, are the only strata in the chalk sufficiently impervious to allow of the construction of a tunnel in the dry. 2. That the outcrop of the chalk marl between Folkestone and the Shakespeare Cliff, is the best position for a tunnel, which could strike the lower part of the chalk marl, and remain in it throughout, so as to join the workings of the French Channel Company, which are being carried on in the same horizon. 3. That the faults in the lower part of the chalk would not now allow of free percolation of water, and are not likely to become a serious obstacle to the work. 4. That the strata above the chalk marl are so porous and traversed by open fissures that they allow of free access to water both sub-aërial and marine. He considers that on the French side the rocks are far more shattered and faulted, and more open to be traversed by water, which is now, however, being successfully contended with by the French Company. The author refers to analyses made of samples of cretaceous rocks. Insoluble material in gault was 45 per cent.; chalk marl (No. 1), 75 per cent.; and only 6 per cent. in the more soluble part of the grey chalk; over the yellow chalk 18 per cent.; while above this it is only 2 per cent. in the lower white chalk without flints. He described the work done by Sir John Hawkshaw in having soundings taken in the English Channel to ascertain the character of the Channel bottom.

On the Proposed Channel Tunnel in its Geological Aspects, by C. E. De Rance, F.G.S., described the sub-divisions found in 1874 in the chalk of Abbott's Cliff, by Mr. Hilton Price and himself, and the impermeable nature of the lower beds, which support a sheet of water met with in springs at the outcrop, and in wells at various points. He regards these underground waters as circulating in the porous white chalk under the sea, and he considers that the artificial abstraction of water by pumping, in making the proposed tunnel in St. Margaret's Bay, will allow the percolation of sea-water to the extent of a million gallons of water in each mile driven daily, and therefore offers great difficulties in the way of the construction of a sub-marine tunnel which are not presented by the lower beds of the chalk marl.

Evidence of Wave Action at a Depth of 40 *Fathoms in the English Channel*, by A. R. Hunt, B.A., describes 16 localities in which pebble have been dredged off the Start Point in 34 fathoms of water, and the discovery of a soda water bottle covered with Serpulæ, and containing 36 species of shells which have been washed in, at a depth of 40 fathoms, by a Brixham trawling fishing boat.

List of Works on the Geology and Palæontology of Oxfordshire, Berkshire, and Buckinghamshire, by W. Whitaker, B.A.—This is a continuation of the County or District Lists, of which a catalogue was given at the head of the Welsh List in the Report for 1880; the present list contains nearly 300 references.

On the Equivalents in England of the "Sables de Bracheux," and of the Southern Limits of the Thanet Sands, by J. Prestwich, M.A., F.R.S.—The author dwells on the importance of establishing in adjacent separate basins, a certain number of well-defined horizons. The lignitic and freshwater beds of the Paris Basin, and of the Woolwich and Reading series, form one such, but he considers the correlation of the beds beneath to be not yet satisfactorily established. The author correlates the Mancheux sands with the lower ends of the Woolwich series, and he is confirmed in this view by M. Desharges, and he further is of opinion that the Thames sands are absent in the Paris Basin.

On the Formation of Flints, by Prof. W. J. Sollas, M.A.—Flints are siliceous pseudomorphs after chalk. Three different stages in their formation are to be distinguished: (1) the silicification of the foraminifera, coccoliths, and calcareous granules of the chalk gives rise to *siliceous chalk*; (2) a deposition of silica follows and produces white or *grey flint*; (3) as the deposition of silica continues it fills up and obliterates the pores of the opaque grey flint, rendering it black and translucent, thus the common *black flint* results. Flint nodules are sometimes found in which all three stages are still represented, but more frequently only the last two: thus grey spots and blotches are seldom absent from black flint, whilst in many cases the two kinds regularly alternate and thus produce the phenomenon of banded flint, which has up to this time remained without any satisfactory explanation.

On some Fossils from the Inferior Oolite, by the Rev. G. F. Whidborne, M.A., and Prof. W. J. Sollas, M.A.—Describes bivalve shells of mollusca chiefly in the Jermyn Street Museum, and 8 new species of sponges, of which 4 belong to 4 new genera.

Mention of an Example of an Early Stage of Metamorphic Changes in an Old Red Sandstone Conglomerate near Aberfoil, by Prof. James Thomson, LL.D., F.R.S., describes fractured quartzite pebbles which he regards as originally a plastic body, which first bent, and then broke, and that the present brittle appearance has been induced at a late era, and he refers their origin to metamorphic action.

On Features in the Glacial Workings noticed on Sandstone Conglomerate at Skelmorlie and Aberfoil, by Prof. James Thomson, LL.D., F.R.S., describes a railway cutting half a mile from Aberfoil. At 150 to 200 feet above the sea occurs striated sandstone, on which were glaciated pebbles, behind which occurred tails of fine material, 5 or 6 feet in length, in the direction in which the ice travelled. Examples have been found by the author showing distinct traces of the ice moving up hill.

Problems in the Geology of the Channel Islands, by the Rev. E. Hill, M.A., states the work done by the late Prof. Ansted leaves much to complete, and is of opinion that there is here a fine field for detailed investigation.

Notes on the Geology and Mining of the United States of Columbia, S.A., by R. B. White.—This paper gives an exhaustive report of the range of metals in time and space in this region, and the application of facts observed, to other districts.

Suggestion for a Revised Classification of the British Eocene, by J. S. Gardner.—Some modification in the classification of the Eocene has become desirable, through the transfer of the Upper Eocene group of Edward Forbes to the Oligocene formation. The discovery of several distinct floras seems also to necessitate certain alterations in order to bring periods founded originally on changes in mollusca into harmony with the more striking changes indicated by the plants. A grouping is suggested which separates the London Clay from the Lower Eocene, and brackets it with the Lower Bagshot Beds as a Middle Eocene. The Middle Bagshot series forms the Upper Eocene, while the Upper Bagshot may remain a member of the same formation, or find a place in the Lower Oligocene. Refers to the changes of climate in the Tertiary epoch.

On the Classification of the Oligocene Strata in the Hampshire Basin, by J. W. Elwes, describes results of investigations in Hampshire and the Isle of Wight. In the latter district he considers that Prof. Edward Forbes was correct in stating that there is only one marine series in the Headon and Brockenhurst group, but he considers, with Prof. Judd, that there are at least two marine zones, the Brockenhurst zone, lying at the base of the series, instead of above the Middle Headon *Venus* bed. The author found the southerly dip at Totland Bay, as described by Prof. Judd, but found no evidence of the local flexure described by that author, by which the latter explains this section, in opposition to the view of the late Edward Forbes.

On the Outcrop of the Brockenhurst Beds near Lyndhurst, by E. Tawney, M.A.—Fossils characteristic of the rich beds which he had been lately working in the railway cutting near Brockenhurst, were found by Mr. H. Keeping, at Cut Walk Hill, Lyndhurst, in 1858. The well at Emery Down, closely adjacent also, yielded the same fossils in 1863. The excavations which the author had lately carried out with the assistance of the Rev. J. Compton, of Minstead, on several sides of this hill, show the succession of the beds to be on the base of the hill. Upper Bagshot sands, next in ascending order, freshwater Lower Heaton, Marine Brockenhurst bed, *Voluta geminata* zone, followed by beds not explored, concluding with the freshwater Osborne marls on the top of the hill. The succession is therefore that of Whitecliff Bay. The thickness of beds between the freshwater Lower Heaton and the Osborne marls is about 100 feet. The discovery of freshwater Upper Heaton beds at Roydon brick-yard was announced.

SECTION D—BIOLOGY

Department of Zoology and Botany

On a New Principle affecting the Systematic Distribution of the Family of the Torpedinidæ; and on the Probable Occurrence of the T. Occidentalis (Storer) on the British Coast, by Prof. Du Bois Reymond, F.R.S.—The author referred to the researches of Prof. Babuchin, of Moscow, on the development of the electrical organs of Torpedo, who has established that these organs are formed by the metamorphosis of striated muscle, and that as they grow they increase in size, not by the addition of new columns and septa, but by the growth of the columns and septa, so that the number is the same in adult and young specimens. He then passed on to the consideration of the part which this fact—known as "delle Chian's and Babuchin's Law—plays in the distribution of the Torpedinidæ. He thought that the average number of columns ought henceforward to form a part of the diagnosis of the species of Torpedinidæ—a matter which has hitherto been entirely overlooked by zoologists. He referred to the species of Torpedo of John Hunter, and showed how Hunter's conclusion that the columns increase in number as well as size was erroneous, and described fully the *T. occidentalis* on the British coasts.

On Cephaliscus, a New Form allied to Rhabdopleura (Allman), by Prof. McIntosh, F.R.S.—This new form was very fully described, and its relation to Rhabdopleura of Allman, which we know as a somewhat abnormal Polyzoön, was discussed. It differs from *Rhabdopleura* in regard to the *cœnæcium*, in the much greater size of the buccal shield, in the remarkable branchial or textacular plumes, in the structure of the pedicle, and the perfectly free condition of the polypides. Cephaliscus and Rhabdopleura agree in the absence of the calyciform membranes connecting the bases of the tentacles, in the position of the mouth, which opens behind the buccal shield, in the general structure of the alimentary canal, and in the position of the anus. The development of the young buds is similar. Both forms connect the ordinary Polyzoa with *Phoronis*.

On an Instructional System of Arrangement in Provincial Museums, by F. T. Mott.—The author suggests a combination of a typical collection of the entire fauna of the globe with that of the local species, the latter being on the ground row, both scientific and vernacular names being given on labels corresponding with a cheap popular guide-book.

Injurious Parasites of Egypt, by Dr. Cobbold, F.R.S.—Egypt is a grand field for the helminthologist, since not only is that country the headquarters, so to say, of one of the most dangerous of human parasites, but it swarms with others possessing scarcely less practical importance, whilst it likewise enjoys the distinction of having made us acquainted with parasitic rarities not known to occur in any other part of the world.

The most dangerous parasite is *Bilharzia hæmatobia*. This was so named by me in honour of Dr. Bilharz, who first discovered it at Cairo in 1851. A few years later I detected the same species of parasite in a monkey; and since the year 1856 confirmatory discoveries and observations, made both at home and abroad, have very greatly extended, though they have by no means completed, our necessary knowledge of the natural history of the creature. In this connection it is fitting that we should signalise the labours of Dr. Prospero Sonsino, whose residence in Egypt has enabled him to contribute facts of great interest. It is to Sonsino that we owe our knowledge of the fact that cattle and sheep are also liable to be infested by *Bilharzia*, but the species is not the same as that which invades man and monkeys.

The *Bilharzia* is a genuine fluke parasite of the digenetic kind, and therefore requiring a change of hosts. It differs from the ordinary sheep-fluke and its allies in being unisexual. In other words we have male and female *Bilharziæ*, the male being the stouter of the two sexes. This is an unusual circumstance amongst parasites. Again, these *Bilharziæ* differ in respect of habitat, for, instead of occupying the liver-ducts and intestinal tract, as most flukes do, they take up their abode within the blood-vessels of the victim.

Although the parasites are individually small, the slender females being less than an inch in length, the presence of any considerable number of them gives rise to a formidable malady, which, in some cases, proves fatal. The disorder thus occasioned has received various names, but it is sufficient to speak of it as the *endemic hæmaturia* of warm climates. Dismissing the purely professional aspect of the affection, and viewing the matter as a question of public health specially affecting European residents in Egypt, I may state that I have recently seen six officers of the Eastern Telegraphic Company, who contracted the disorder in the neighbourhood of Suez, and also another gentleman who obtained the parasite in Natal. In all of these instances the immediate cause of the parasitic invasion was due to their having carelessly drank unfiltered water. In all the Egyptian cases this took place during shooting expeditions along the banks of the Cairo-Suez Canal.

Thus, all the evidence of a practical sort that we have obtained as to the cause of the endemic is in perfect harmony with that which has been derived from scientific inquiry. So far as our investigations have been pushed, it is clear that in respect of *Bilharzia hæmatobia*, the natural history phenomena do not differ in any very essential particular from those that occur in the case of ordinary flukes. We have a similar mode of origination, the same rapid growth and development attended with metamorphosis, and likewise a change of hosts.

Practically it is of little moment what water snail or other aquatic organism holds the cercaria of Bilharzia. Infection follows as well from the ingestion of the free-swimming cercaria as from the ingestion of the intermediate hosts. It comes to the same thing in the end. Canal water-drinking in Egypt is the direct cause of the Bilharzia infection, and of the consequent endemic hæmaturia. This being so, simple filtration is in most cases a sufficient protection. To European residents, therefore, the drying up or damming up of the fresh-water canals is not an unmixed evil, because it insures greater freedom from parasitic dangers; moreover, it induces efforts to remedy the evil. Of course these efforts will correspond in magnitude with the necessities of the case.

Unfortunately, there are other parasites whose entrance into the human body by means of water-drinking is of constant occurrence, and they are often found associated together in one and the same person. The other specially obnoxious endemic worms are *Anchylostoma duodenale* and *Filaria sanguinis hominis*. Speaking of the collective *rôle* of the three parasites, Dr. Sonsino says that "they concur in the production of a large mortality of the natives," and the mischief they thus occasion "is not sufficiently appreciated."

How fatal the *Anchylostoma* may prove in other countries than Egypt was recently seen in the endemic outbreak which carried off some of the labourers during the formation of the St. Gothard Tunnel. Many disputes and misunderstandings at first prevailed respecting the *rôle* of this Entozoon. Having been called "tunnel trichinosis," this disorder got sadly mixed up with affections having a totally different character and history. Similarly, the blood-letting habits of *Bilharzia* and *Anchylostoma* having produced analogous symptoms, the two disorders were called Egyptian chlorosis, intertropical anæmia, and so forth. Recently our knowledge of the geographical distribution of the Anchylostoma has been extended by the discovery of Prof. McConnell, who finds that the parasite is more or less prevalent in India, Wherever it is to be found, its power for mischief is the same, and its mode of entrance into the human frame can only occur through the medium of water.

As regards dangers arising from external attacks by water parasites, little need be said. Troops invading foreign lands are now better furnished than formerly in the matter of clothing and other protective aids; still there are points worth mentioning, especially as in the heat of a campaign the distress from thirst often compels the soldier to drink the filthiest of waters. One quotation will suffice During the invasion of Egypt by Napoleon, the French soldiers were much distressed, and often laid themselves flat on the ground to drink. Their mouths and nostrils were thus attacked by leeches. The species responsible for these assaults is the *Hæmopis sanguisorba* of Savigny. These free parasites not only attacked the men, but also their horses, camels, and cattle.

On the Brown Coloration of the Southampton Water, by Arthur Angell, Ph.D.—The author has found that this coloration is very irregular, and even occurs in isolated patches; he showed that the coloration is due to a brown organism (*Pendininm fuscum*); he has been able to obtain from it brown and green solutions, which both give the spectroscopic appearances characteristic of chlorophyll. He discussed its probable animal or vegetable nature, but favoured the latter view.

Department of Anatomy and Physiology.

Dr. Fraser proceeded to the description of his results on the early development of certain rodents, illustrating his remark by drawing on the board. He showed that the guinea-pig, instead of standing isolated among mammalia by its peculiar form of development, shared this isolation among rodents with the rat and the mouse. He traced the history of the ovum from the sixth day after union of the sexes, up to the formation of the allantoic circulation. Dr. Fraser, whose work is still incomplete, but who is at present busy with the earliest condition of the ovum, offered no explanation of this important result. He insisted, however, upon the hypoblastic layer being external from the close of segmentation, and that the inversion of the layer therefore existed in these three animals from the earliest segmentation phenomena.

Prof. Allen Thompson made some remarks upon the general excellency and result of the work as changing our ideas on the mammalian development, and stated that as Kölliker had just found the hypoblastic layer in the amnion of the rabbit, we must be prepared for great changes in our received opinion on this subject.

On the Homologies of the long Flexor Muscles of the Feet of Mammalia, by G. E. Dobson, M.A., M.B..—Dr. Dobson dealt with the homologies of the following muscles:—Flexor Digitorum fibularis = Flexor hallucis longus; 2. Flexor Digitorum tibialis = Flexor Digitorum longus; 3. Tibitalis positicus. He explained by means of drawings how these muscles partially or totally supplanted one another in different animals. From the examination of a large number of animals he fonnd the *flexor fibularis* existing in all and exhibiting but few modifications, while the other two were subject to much variation, or might be absent. He deduced from his dissections that the variation of the *flexor tibialis* had not been properly understood, its real homologues having been named *tibialis porticus accessorius secundus*, or *internus*, while it was supposed the muscle had undergone fusion with the *flexor fibularis.*

On the Nature of the "Telson" and "Caudal fusca of the Crustacea," by M. M. Hartog, M.A., D.Sc.—Dr. Hartog sent a short paper to explain that the telson in the higher crustacea is equivalent to the last segment of the Nauplius body, together with an immensely developed postanal portion composed in varying proportions of the supra-anal plate and the adnate fuscal processes. The fuscal processes he regards as outgrowths of this telson not strictly comparable to limbs, but rather to the primitive-paired outgrowths of the body-segments which have become limbs elsewhere by the development of basal articulations and a proper musculature.

Considerations arising from Koch's Discovery of the Bacillus of Tuberculosis, by F. J. Faraday, F.L.S.—Two great discoveries, Pasteur's discovery of the decreasing virulence of specific disease germs when kept in the presence of oxygen, and Koch's discovery of the bacillus of tuberculosis, have been made within the past two years. The author suggests a possibly useful relation between these discoveries. Referring to the suggestion of Dr. William Roberts, F.R.S., of Manchester, in his address to the Medical Association in 1877, that disease germs may be "sports" from harmless saprophytes which have acquired a parasitic habit, he asks whether deprivation of oxygen, or cultivation in gaseous mixtures from which the normal supply of free oxygen present in good air is absent, may not have an influence in converting harmless germs present in the atmosphere into the bacilli of tuberculosis. He refers to Carl Semper's researches on the influence of the environment on animal modification, and to the fact that many larvæ of insects live in situations where the air is undoubtedly mixed with gases which the higher vertebrata could not breathe without injury, and suggests that the adaptability of organisms, and their impressionability by surrounding conditions, may increase as the scale of life is descended. He also refers to a paper by Mr. Frank Hilton, F.C.S., read before the Chemical Society, on experiments with bacteria in various gases. Mr. Halton gave the chemical results, but it would be interesting to know the influence of cultivation in such media on the character of the bacteria themselves. Dr. Angus Smith has argued that the putrefying process, when carried on in confined places, such as sewers, may develop disease germs which are not developed when the same process goes on in unconfined places; typhoid fever seems to be developed by processes in sewers, which, carried on in the Clyde, for instance, do not originate any well-marked disease. Analogous conditions may be presented in the lungs of persons engaged in dusty trades, breathing vitiated atmosphere in ill-ventilated rooms, or engaged in sedentary occupations, and not taking healthy exercise; and also in the lungs of persons who are hereditarily narrow-chested, weakly, and of feeble inspiratory habit. Innoxious germs present in the atmosphere may be inhaled and retained in the lungs of sush persons, and there by successive culture and deficient aëration acquire a parasitic or deadly character. The author refers to Pasteur's method of restoring the virulence of "attenuated" germs by successive culture in the bodies of different animals, as possibly explaining the communication of tuberculosis to persons of sound constitution, the parasitic habit of the tubercle "sport" being so strengthened and confirmed by successive culture under the assumed favourable conditions as to enable it eventually to establish itself under certain conditions in a *milieu* which would not be suitable for the origination of the culture. He refers to a new treatise by Dr. Ferdinand Kroczak, of Brünn, entitled "Die Heilung der Tuberculose," and shows that Dr. Kroczak's arguments in support of the special treatment recommended by him are in harmony with the hypothesis advanced.

The decrease of mortality from consumption in the army since the improvement of barrack ventilation, and the relief afforded to patients by sea-voyages, the air of pine-woods, carbolic acid inhalations, and other suggested remedies, is also referred to as giving support to the hypothesis.

On the Kidneys of Teleostei, by W. Newton Parker. In following the investigations of Prof. Balfour, who showed that in certain adult Teleostei, as well as in Lepidosteus and Accipenser, the so-called "head kidney" contained no urniferous tubules, but was composed entirely of highly vascular lymphatic tissue, the author finds that in some Teleostei the so-called "head-kidney" has precisely the same structure as the rest of the kidney in mesonephros. He nevertheless holds that Prof. Balfour's view is correct, and explains the circumstance by supposing that the mesonephros has grown forwards so as to take the place of the larval pronephros.

On the Perception of Colour in Man and Animals, by Dr. S. D. Macdonald, R.N.—Dr. Macdonald read a paper, in which he endeavoured to show the near relationship of perception of sound and light, comparing different colours to different notes.

On the Structure of the Muscular Tissue of the Leech, by T. W. Shore.—The author described his research, summing up as follows:—1. The muscle of leech consist of elongated tubes with two coats—a sarcolemma and contractile layer—the inner surface of which is irregular, and gives rise to an apparently granular contents. 2. In living condition it is unstriped. 3. There are no nuclei. 4. Transverse striation may be produced post-mortem, the result of three changes:—α. Regular arrangement of the papillæ on the inner surface of the contractile layer. β. Folding of the surface of the sarcolemma. γ. Splitting into segments of the contractile substances which subsequently contract. 5. The contractile substance coagulates, forming myosin, which subsequently contracts. 6. The rapidity of contraction gives rise to varying appearances of fissures, striations, &c.

An Improved Method of Direct Determining of the Contraction Wave in Curarised Muscle, by E. A. Shaafer, F.R.S.—In this method, instead of using levers which write directly on a blackened surface, the levers are caused to successively break galvanic circuits connected with a Ruhmkorff induction apparatus, the ends of the secondary coil being so arranged that the sparks are transmitted through a sheet of smoked paper, turned rapidly by means of a spring myograph. A time tracing is at the same time recorded on the paper.

On the Presence of a Tympanum in the Genus Raca, by G. B. Howes.—The author regards a fenestra (long known to exist) in the roof of the auditory capsule of the genus and its adjacent parts, to be a modification of what is seen in other species, which is correlative of the compression from above downwards undergone by it, resulting in the formation of a tympanum physiologically foreshadowing the essential process involved in the elaboration of the auditory organ of the higher forms.

Prof. H. N. Martin, D.Sc., explained briefly his method of isolating the mamalian heart for experimental purposes.

Dogs were used: these being etherised, were then kept alive by artificial respiration; all systemic vessels, with the exception of the thoracic aorta and the superior cava were then ligatured. The heart is now supplied by defibrinated dog's or calf's blood by means of a Marriot's flask, the whole animal being kept in a moist and warmed chamber. Dr. Martin by these means has found that either the venous or aortic pressure may be varied in very great limits without the rate of the beat being altered, but by increasing the venous pressure very slightly, the work done by the organ was vastly increased. These researches are, however, only preliminary.

On some Toxic Conditions of the Blood illustrated by the Action of Hydrocyanic Acid, by T. S. Ralph.—Having found some apparently amyloid matter in the blood-corpuscles of patients taking hydrocyanic acid, Mr. Ralph has examined the subject, and brought forward some observations which tended to show that this may occur in recent paralysis, and the exhibition of various remedies.

Department of Anthropology

Evidence as to the Scene of Man's Evolution and the Prospects of Proving the same by Palæontological Discovery, by W. S. Duncan, M.A.I.—Mr. Duncan urged that a Committee should be appointed to investigate fossil forms proving the evolution of man. The author advanced a series of arguments in favour of the region of the South of Europe and Asia as the probable scene of man's evolution as a likely field of successful exploration.

Ebb and Flow in Mental Endowment, by G. Harris, F.S.A. —The theory propounded by Mr. Clarke was that an ebb and flow in mental capacity and moral quatities may often be discovered in the successive generations of particular families. The writer referred to the supposed transmission of endowments acquired by cultivation, and started the inquiry whether the condition of the parent at the time of procreation of the child is that from which the transmission of such qualities is derived.

On some Customs of the Aborigines of the River Darling, New South Wales, by F. Bonney.—Mr. Bonney gave the result of his own observations, during many years' residence, on the customs of the race, and especially on the rites and ceremonies relating to marriage, coming of age, burial, mourning, &c., and an account of the many superstitions relating to the healing art, detection of murderers, &c. The paper was illustrated by a large number of valuable photographs.

The Light thrown by the Explorations of Caves on the Conquest of Britain, by Prof. Boyd Dawkins, F.R.S.—The lecturer brought forward much important evidence drawn from the exploration of caves in Ayrshire and other localities as to the places to which the Britons retreated as the advancing Anglians spread westward.

SECTION G—MECHANICAL SCIENCE.

Mr. B. Baker read a paper on *The Forth Bridge*, of which we recently gave an account, (*Nature*, vol. xxv. p. 246). The author gave an amusing illustration of the size of this new bridge. The stature of a new born infant being 19·34 inches, the average height of a guardsman 5 feet 10½, the ratio of these two is as 1 : 3·65, and this is exactly the ratio of the span of the Forth bridge to that of the largest bridge at present in this country, viz. the Britannia bridge. The account above alluded to dealt principally with the questions of size and strength; the paper in addition to these points dealt with the history of negotiations and Parliamentary proceedings, and then with mode of construction, weight of materials to be used, and probable cost. No less than 42,000 tons of steel will be used in the superstructure of the main spans and 3000 tons of wrought iron in that of the viaduct approach. The total quantity of masonry in the piers and foundations would be about 150,000 cubic yards, and the estimated cost of the entire work was about £1,500,000 though from the magnitude and novelty of the undertaking this must be regarded as only an approximate figure. A very fine model of the proposed bridge was placed in the room.

On the Treatment of Steel for the Construction of Ordnance, by Sir W. Armstrong.—The author alluded to the want of a proper definition of steel. The term was formerly confined to iron containing a much greater proportion of combined carbon than was to be found in the so-called mild steels of the present day. The chief distinction between iron and steel now seemed to be in the process of manufacture, steel being operated upon in the state of fusion, while iron was dealt with in a state of agglutination. But even mild steel contained more carbon than was generally to be found in wrought iron and that excess small as it was, appeared to exercise a very important influence upon its qualities. These qualities had been brought out in a marked way in some investigations he had occasion to make in welding, tempering, drawing, and annealing. The experiments were then detailed and the specimen of steel shown to the meeting. One important conclusion was that there was much less sacrifice of ductility and toughness in obtaining strength by tempering, than by increase of carbon. The saving in weight of steel for a given purpose would thus in the case of bridges and similar structures, amply repay the cost of tempering.

Mr. T. R. Wrighton read a paper on *The Increased Tenacity in Perforated Test Bars of Iron and Steel* which together with the former paper elicited a very interesting discussion, particularly with reference to the curious phenomenon dealt with in the latter. Several explanations of the result have been given, but it appears tolerably certain that the section of the test bar under tension is not decreased to the same proportial extent when perforated as when solid, and this the author appeared to think was due to the cutting through of the diagonal lines of stress by the drilled holes.

On the Channel Tunnel, by Mr. J. Clarke Hawkshaw.—The author commenced by giving an account of the steps which had hitherto been taken in the matter, stating that there were two schemes for carrying out the work. That by the South Eastern Company was the one of which the public had hitherto chiefly heard, while the Channel Tunnel Company had been silent, waiting for the promised Parliamentary enquiry. He then proceeded to discuss the geological aspect of the question in a most able and explicit manner. The plan he advocated may be briefly described as one to bore a tunnel which should approach the coast of this country east of Dover so as to enable the line to rise by the necessary gradient to the town. He proposed to take the shortest possible route and instead o deviating from the straight line to avoid the chance of coming upon water bearing fissures, to aim rather at dealing with the water from this cause by powerful pumping apparatus. He argued to show that the amount of water so met with would probably be quite within the power of pumps to deal with. The advantages to be gained from making a tunnel direct from Fainhole to Sandgatte were:—The shortest sea tunnel; as short a land tunnel, as by any line; a greater thickness of chalk through which to tunnel; the best termination for effecting junctions with the existing English railways; and a termination affording facilities for defence at a less cost than elsewhere. He criticised at length other proposed routes, and finally dealt with the proposed system of ventilation.

On the system of Excavating the Channel Tunnel by Hydraulic Machinery, by Mr. T. R. Crampton.—The principal feature in this proposal is that of driving the chalk cutting machinery by hydraulic power, the waste water being discharged into a vessel with the chalk *débris*. Chalk "cream," is then formed by the revolution of a drum in this vessel, and this cream is pumped to the head of the working and discharged.

Three papers were read by Major Allen Cunningham R.E., whose recently published work in connection with the Hydraulic Experiments at Roorkee, gives this country a position with regard to the subject, which it certainly could not previously claim. The following are brief extracts:—*On unsteady Motion in Open Channels:* The motion of water in open channels is essentially an *unsteady motion with interlacing stream lines;* the hypothesis of steady parallel motion is at variance with nature. Single velocity measurements are of little practical use, being only accidental values; the average of a large number is pretty constant, so that the *average velocity* should always be sought. The time needed to obtain these involves a chance of change of the external conditions. In practical hydraulics the forward velocity is the only velocity considered or required. Floats measure this directly; no other instruments yield this quantity readily in large streams. These principles are of great importance, and show that hydraulic experiments must always be tedious and expensive.—*Convexity of the Surface of Streams:* The figure of the transverse section of the free surface of a stream, usually supposed to be convex, is here considered. The evidence is shown to be very small. Some new special experiments are cited. The conclusion is that the surface is probably level across.—*Depression of Maximum Velocity:* The line of maximum velocity in an open channel is usually below the surface. The cause of the depression is obscure. The wind and disturbances from the banks and bed are usually supposed to be the causes. The wind is probably too inconstant. The disturbances from the banks and bed seem an inadequate explanation. The general depression of the maximum velocity on all verticals at all parts of a channel indicates some resistance from above. The motion in open channels and in rivers flowing full shows some similarity with differences in detail fairly accounted for by supposing the air to be an ever present efficient drag or source of resistance to forward surface-flow, less intense than the banks or bed. If this be admitted the hydraulic term "wet border" must be modified so as to include *all parts* of the wet border, each with its own specific resistance.

On Compressed Air as applied to Locomotion, by Sir F. J. Bramwell.—The author dwelt upon the cases in which compressed air might be advantageously employed for this purpose, as for instance in the proposed Channel Tunnel and on tramways. For the latter, some altered means of traction seems for several reasons inevitable. One of these reasons is the undoubted cruelty to horses which is the result of the present system. The fact that compressed air can be satisfactorily used for this purpose is proved by the tramways of Nantes, which for three years and a quarter have been worked by this means. The various difficulties to be expected on any tram-line, such as those from curves and gradients, are to be found on that one which, running beside the River Loire, connects Doulon and Chantonay. The cars run every ten minutes from both ends of the line for fifteen hours each day in summer, and fourteen hours in winter, and during the time above mentioned there has been no hitch whatever. An arrangement called the "Hot Pot" is used to obviate the loss of energy and the inconvenience arising from the well-known fact that air becomes heated when being compressed, and cools upon expansion. The apparatus consists of a vessel of water into which steam is forced at the conclusion of each journey. Through this heated water the compressed air is passed, and is thus at the same time heated and lubricated. An ingenious form of regulating-valve was also described, by means of which a uniform working pressure is maintained, whatever may be the pressure in the air reservoirs. The two contrivances are combined, and together effect: (1) a great saving of power, and (2) a trustworthy mode of regulating the pressure. Details of the engines and pumps at the stations were given, these together working with the high efficiency of 82 per cent., that is, with a loss of only 18 per cent. of the total energy. The expenditure of fuel per day, under the conditions already given, is only 4½ tons of coal, or a little more than 12½ lbs. per mile run.

Three papers were read by Dr. Fleming. The first upon *Recent Progress in Electric Railways* was practically a description of an experimental railway laid down by Mr. Edison in Menlo Park. The plan there adopted is to connect one rail at regular distances with one of the terminals of a dynamo in a central station, the other rail being similarly connected with the opposite terminal. The motor has externally the appearance of an ordinary locomotive without a funnel, containing, however, a dynamo, by means of which short circuiting between the rails is prevented, and the motive power obtained. The percentage of useful effect claimed by the author was exceedingly high, only 5 lbs. of coal per hour per H.P. being used, as against 6 lbs. with an ordinary locomotive. A speed of 40 miles an hour, over 8 or 10 miles, was stated to have been attained. These statements of the author concerning the efficiency of the system described by him, were called in question by the President, Prof. Forbes, and others, who complained of the meagre supply of facts upon which to form an opinion on such an important question. Dr. Werner Siemens, at the request of the President, made some remarks with reference to his own experience in electric railways, stating the loss of power to be one-fifth in winter, and one-eighth in summer. Amongst other things he advocated overhead connection of wires to convey the current. The other papers by Dr. Fleming were upon electric lighting and the efficiency of the Edison dynamo.

Prof. Forbes described a very simple and ingenious form of electric lamp, and then read a paper giving results of experiments on wires conveying currents, which he had embodied in two laws. These laws define the strength of current which can be sent through wires of different diameters without raising the external temperature above a certain limit. Law I. When the wire is bare and exposed to the air, the strength of current is proportional to the diameter of the wire. Law II. When the wire is wound in coils of the same size and weight, the strength of current is proportional to the diameter of the wire. To discover the first law, a thin coating of wax was put upon each wire, and a current gradually increasing in strength was passed through it until the wax melted. The strength of the current was then read off on a galvanometer. To discover the second law, two equal tubes were wound with many layers of wire until they were of equal weight; these were filled with water and a thermometer bulb inserted. The currents required to raise the temperature in each equally were measured.

Mr. Barlow read a paper *On the Mechanical Properties of Aluminium.* This metal is used chiefly as a substitute for silver, but the author had found it to be exceedingly strong in proportion to its weight. Experiments had been carefully made for him by Prof. Kennedy, from which its valuable properties of ductility, tensile strength, and elasticity were fully demonstrated. This was well illustrated by the comparative length of rods of uniform section, but of different metals, which could be suspended without rupture, the lengths in the case of steel and aluminium being equal and exceeding all others. Unfortunately it is an expensive metal, and the process by which it is at present extracted leaves little hope of its use being greatly extended. Sir H. Bessemer said he did not think any metal could be depended on like the one in question, from the small part its weight took in producing its rupture. He exhibited a key of the material (about the size of a large latch key), and it was stated that 45 of these would only weigh one pound.

Mr. A. Giles read a paper on *The Southampton Docks.* This paper was listened to with considerable interest, from the fact of proposed local changes, which, if carried out, would considerably affect the port. The paper not only gave a history of the present works, and dealt with the future improvements, but also gave statistics of the trade of the docks as a commercial undertaking.

Mr. Price Edwards read a paper *On Sound Signals,* discussing the various signals used on railways, ships, and the coast. He stated that a change was about to be introduced in connection with the Trinity House signals, in which a combination of high and low notes was to be used. A trial of explosive signals was also shortly to be undertaken. Allusion was made to the unnecessary shrillness of railway whistles.

Prof. W. C. Unwin read a paper on *Current Meter Observations in the Thames.* The author described and exhibited the instrument which he had used. This meter differs from most other meters in its mode of suspension, being lowered into the water by a stout wire from a boat, proper orientation being secured by a tail or vane. The instrument is very convenient to use, observations being taken by one observer at an average rate of one in three minutes. The results obtained were exhibited by curves.

Sir F. J. Bramwell exhibited and explained the action of a speed indicator. This instrument had been designed and employed by him in connection with experiments upon railway trains. It consists of a drum turned by clockwork, over which a continuous slip of paper passes. This paper is marked by two pencils which can at any time be brought into contact with it. One of these gives a straight line which shows the beginning, ending, and line of duration of an experiment. The other receives a reciprocating motion from one of the wheels of the locomotive, and so gives a continuous series of curves, the relative closeness of which to each other measures the speed of the train. From results given by this instrument a very instructive curve was drawn, showing the manner in which a train comes to rest. Experiments were made on a piece of level line on the Midland Railway, between Nottingham and Newark. On a calm day a train weighing 125 tons, and moving at the rate of 45 miles an hour, ran 5 miles and 5 yards after the steam was shut off.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, August 2.—Mr. F. D. Godman, M.A., F.R.S., vice-president, in the chair.—One new Member was elected.—Exhibitions: *Macropis labiata*, by Mr. F. Enock; *Paragus tibialis* and *Discomyza incurva*, by Mr. T. R. Billups; *Cicindela*, sp. from Babylon, by Miss E. A. Ormerod; *Xyleborus saxesenii* (destructive to ale-casks sent out to Rangoon), by Mr. W. L. Distant.—Papers read: Notes on the life-history of *Sitones lineatus*, by Mr. T. H. Hart, read by Miss Ormerod.—On a visit to Ceylon, and the relation of Ceylonese beetles to the vegetation there, by Mr. G. Lewis, who had captured about 1200 species of beetles in Ceylon in five months.—On certain temperature forms of Japanese butterflies, by Mr. H. Pryer.

PARIS

Academy of Sciences, August 21.—M. Boussingault in the chair.—The following papers were read:—On longitudinal shock of a free elastic bar against an elastic bar of other matter or of another size, fixed at the end not struck; consideration of the extreme case in which the striking bar is very rigid and very short, by M. de Saint-Venant.—On the vaso-motor effects produced by excitation of the peripheric segment of the lingual nerve, by M. Vulpian. This nerve seems to have a certain degree of recurrent sensibility, manifested on stimulating the peripheric segment of the cut nerve, by contraction of the vessels in the opposite half of the tongue.—On the appearance of manganese on the surface of rocks (continued), by M. Boussingault. This relates chiefly to the *Challenger* observations. The sea and rivers contain carbonic acid favouring the dissolution of insoluble carbonates. When, from any cause, the acid gas is expelled, the salts are precipitated; the carbonates of protoxide of iron and protoxide of manganese, once in contact either with the oxygen of the air, or with that dissolved in the water, are modified by sur-oxidation of their bases; the carbonate of iron produces a red sesquioxide, the carbonate of manganese a black oxide.—Some observations on the phylloxeras of Savoy, by M. Lichtenstein. The multiplication is very much less in Savoy and other regions, where the temperature is below 20° to 25° in summer. Seven species of phylloxera are now distinguished in France. — Observations at Marseilles Observatory, by M. Borrelly.—On the solar metallic eruptions observed at Rome during the first half of 1882, by P. Tacchini. Forty-three were observed, twenty-four north of the solar equator, and nineteen south. A maximum occurred in March. The number of lines was always small, and the solar activity was far from that of the preceding epoch of maximum. The line *Bc* was the most frequent. The only splendid eruption was on June 21; its maximum height was about 167″. The maxima of the eruptions were between ± 10° and ± 20°, nearly as with the spots; but they extended to greater latitudes.—Broadening of the spectral lines of hydrogen, by M. Van Monckhoven. He concludes from experiments that the broadening is quite independent of temperature, and solely due to pressure.—On the longitudinal shock of an elastic rod fixed by one of its extremities, by MM. Sébert and Hugoniot.—On approximate quadratures and cubatures, by M. Mansion.—Hydrodynamic experiments; imitation by liquid or gaseous currents of stratifications of the electric light in rarefied gases and of various forms of the electric spark (seventh note), by M. Decharme. He moves horizontally and quickly over a plate covered with minium, a tube with issuing current of liquid or air.—Remarks on the subject of M. Tommasi's communication on the numerical relations between thermal data, by M. Le Blanc.—On a synthetic type of Annelid (*Anoploncreis Hermanni*) commensal of *Balanoglossus*, by M. Giard.—The quaternary formation of Billancourt, by M. Riviere.—Chemical composition of the banana at different degrees of maturation, by M. Ricciardi. The green banana contains about half of its weight of starch, which disappears in the ripe fruit, and the sugar in the fruits ripened on the plant is almost entirely cane sugar; that of the fruits ripened after gathering, four-fifths inverted sugar, the rest cane sugar. The tannic substances and organic acids of the green fruits disappear in the ripe fruits. M. Ricciardi considers the CO_2 produced by the banana in the third period of its maturation is not due to alcoholic fermentation.—On modifications of the epidermic structure of leaves under various influences, by M. Mer.—Observations on an earthquake at Couchey (Côte d'Or), by M. Guillemot. This occurred at 4.25 a.m., on August 14; a single dull shock was followed by an oscillation south-south-east to north-north-west, lasting half a second. The shock was felt over at least 14 kilometres.

August 28.—M. Wurtz in the chair.—M. Mouchez communicated an address he had given at the inauguration of a statue to Fermat at Beaumont-de-Lomagne.—Meridian observations of small planets and of the comet Wells, at Paris Observatory, during the second quarter of 1882, by M. Mouchez.—On the inclination of the magnetic needle, by M. d'Abbadie. His observations with an inclination-needle of MM. Brunner, only 0·063m. long, prove its accuracy.—Communication on black phosphorus, by M. Thenard. As against doubts of the existence of black phosphorus, he states that lately, when moulding phosphorus in the usual way, and after getting a dozen rods, all of the ordinary colour, the thirteenth blackened suddenly throughout at the moment of cooling. The phenomenon was afterwards reproduced in a partial way.—Separation of gallium (continued), by M. Lecoq de Boisbaudran.—A communication by M. Chevreul affords evidence that Joseph Hubert, the friend and successor of Poivre in the island of Reunion, recognised, as early as 1788 (some ten years before English and German *savants*), the gyratory character of cyclones. In 1818 Hubert got the complete and correct formula expressing their double motion of gyration and translation (several years before Dove).—Observations of planets 227 and 229 with the western equatorial of the garden of Paris Observatory, by MM. Henry.—Solution of the problem of Kepler for considerable eccentricities, by M. Zenger.—On the formation of secondary couples with plates of lead, by M. Planté. He accelerates the formation of the couples, by first keeping them immersed twenty-four hours in nitric acid diluted one-half of its volume with water. The porosity produced extends the chemical action, which occurs on alternation of the primary current. These couples, in eight days, and after three or four changes of direction of the primary, yield results which were formerly obtainable only after several months' treatment.—M. Larroque presented a note on the transport, by lightning, of ferruginous particles contained in dust of the air. To this he attributes the persistence of the magnetic property observed in certain trees.

CONTENTS

THURSDAY, SEPTEMBER 21, 1882

PSYCHOLOGICAL DEVELOPMENT IN CHILDREN

Die Seele des Kindes, Beobachtungen über die geistige Entwickelung des Menschen in den ersten Lebensjahren. Von W. Preyer, ordentlichem Professor der Physiologie an der Universität und Director des physiologischen Instituts zu Jena, etc. (Leipzig: Th. Grieben, 1882.)

THIS is a large octavo volume, extending to over 400 pages, and consisting of daily observations without intermission of the psychological development of the author's son from the time of birth to the end of the first year, and of subsequent observations less continuous up to the age of three years. Prof. Preyer's name is a sufficient guarantee of the closeness and accuracy of any series of observations undertaken with so much earnestness and labour, but still we may remark at the outset that any anticipation which the reader may form on this point will be more than justified by his perusal of the book. We shall proceed to give a sketch of the results which strike us as most important, although we cannot pretend to render within the limits of a few columns any adequate epitome of so large a body of facts and deductions.

The work is divided into three parts, of which the first deals with the development of the Senses, the second with the development of the Will, and the third with the development of the Understanding.

Beginning with the sense of Sight, the observations show that light is perceived within five minutes after birth, and that the pupils react within the first hour. On the second day the eyes are closed upon the approach of a flame; on the 11th the child seemed to enjoy the sensation of light; and on the 23rd to appreciate the rose colour of a curtain by smiling at it. Definite proof of colour discrimination was first obtained in the 85th week, but may, of course, have been present earlier. When 770 days old the child could point to the colours yellow, red, green, and blue, upon these being named.

The eyelids are first closed to protect the eyes from the sudden approach of a threatening body in the 7th or 8th week, although, as already observed, they will close against a strong light as early as the second day. The explanation of their beginning to close against the approach of a threatening body is supposed to be that an uncomfortable sensation is produced by the sudden and unexpected appearance, which causes the lids to close without the child having any idea of danger to its eyes; and the effect is not produced earlier in life because the eyes do not then see sufficiently well. On the 25th day the child first definitely noticed its father's face; when he nodded or spoke in a deep voice, the child blinked. This Prof. Preyer calls a "surprise-reflex"; but definite astonishment (at the rapid opening and closing of a fan) was not observed till the 7th month. The gaze was first fixed on a stationary light on the 6th day, and the head was first moved after a moving light on the 11th day; on the 23rd day the eyeballs were first moved after a moving object without rotation of the head; and on the 81st day objects were first sought by the eyes. Up to this date the motion of the moving object must be slow if it is to be followed by the eyes, but on the 101st day a pendulum swinging forty times a minute was followed. In the 31st week the child looked after fallen objects, and in the 47th purposely threw objects down and looked after them. Knowledge of weight appeared to be attained in the 43rd week. Persons were first distinguished as friends or strangers in the 6th month, photographs of persons were first recognised in the 108th week, and all glass bottles were classified as belonging to the same genus as the feeding-bottle in the 8th month.

With regard to the sense of Hearing, it is first remarked that all children for some time after birth are completely deaf, and it was not till the middle of the 4th day that Prof. Preyer obtained any evidence of hearing in his child. This child first turned his head in the direction of a sound in the 11th week, and this movement in the 16th week had become as rapid and certain as a reflex. At 8 months, or a year before its first attempts at speaking, the infant distinguished between a tone and a noise, as shown by its pleasure on hearing the sounds of a piano; after the first year the child found satisfaction in itself striking the piano. In the 21st month it danced to music, and in the 24th imitated song; but it is stated on the authority of other observers that some children have been able to sing pitch correctly, and even a melody, as early as 9 months. One such child used at this age to sing in its sleep, and at 19 months could beat time correctly with its hand while singing an air.

Concerning Touch, Taste, and Smell, there is not so much to quote, though it appears that at birth the sense of taste is best developed, and that the infant then recognises the difference between sweet, salt, sour, and bitter. Likewise, passing over a number of observations on the feelings of hunger, thirst, satisfaction, &c., we come to the emotions. Fear was first shown in the 14th week; the child had an instinctive dread of thunder, and later on of cats and dogs, of falling from a height, &c. The date at which affection and sympathy first showed themselves does not appear to have been noted, though at 27 months the child cried on seeing some paper figures of men being cut with a pair of scissors.

In the second part of the book it is remarked that voluntary movements are preceded, not only by reflex, but also by "impulsive movements"; the ceaseless activity of young infants being due to purposeless discharges of nervous energy. Reflex movements are followed by instinctive, and these by voluntary. The latter are first shown by grasping at objects, which took place in Preyer's child during the 19th week. The opposition of the thumb to the fingers, which in the ape is acquired during the first week, is very slowly acquired in the child, while, of course, the opposition of the great toe is never acquired at all; in Preyer's child the thumb was first opposed to the fingers on the 84th day. Up to the 17th month there is great uncertainty in finding the mouth with anything held in the hand—a spoon, for instance, striking the cheeks, chin, or nose, instead of at once going between the lips; this forms a striking contrast to the case of young chickens which are able to peck grains, &c., soon after they are hatched. Sucking is not a pure reflex, because a satisfied child will not suck when its lips are properly stimulated, and further, the action may be originated centrally, as in a sleeping suckling. At a later stage biting is as instinctive as sucking, and was first observed to occur in the 17th week with the toothless gums. Later than biting, but still before the teeth are cut, chewing becomes instinctive, and also licking. Between the 10th and the 16th week the head becomes completely balanced, the efforts in this direction being voluntary and determined by the greater comfort of holding the head in an upright position. Sitting up usually begins about the 4th month, but may begin much later. In this connection an interesting remark of Dr. Lauder Brunton is alluded to ("Bible and Science," p. 239), namely, that when a young child sits upon the floor the soles of its feet are turned inwards facing one another, as is the case with monkeys. When laid upon their faces children at earliest can right themselves during the 5th month. Preyer's child first attempted to stand in the 39th week, but it was not until the beginning of the 2nd year that it could stand alone, or without assistance. The walking movements which are performed by a child much too young to walk, when it is held so that its feet touch the ground, are classified by Preyer as instinctivé. The time at which walking proper begins varies much with different children, the limits being from 8 to 16 months. When a child which is beginning to walk falls, it throws its arms forwards to break the fall; this action must be instinctive. In the 24th month Preyer's child began spontaneously to dance to music and to beat time correctly.

A chapter is devoted to imitative movements. At the end of the 15th week the child would imitate the movement of protruding the lips, at 9 months would cry on hearing other children do so, and at 12 months used to perform in its sleep imitative movements which had made a strong impression while awake—*e.g.* blowing; this shows that dreaming occurs at least as early as the first year. After the first year imitative movements are more readily learnt than before.

Shaking the head as a sign of negation was found by Preyer, as by other observers, to be instinctive, and he adopts Darwin's explanation of the fact—viz. that the satisfied suckling in refusing the breast must needs move its head from side to side. In the 17th month the child exhibited a definite act of intelligent adjustment, for desiring to reach a toy down from a press it drew a travelling-bag from another part of the room to stand upon. We mention this incident because it exhibits the same level of mental development as that of Cuvier's orang, which on desiring to reach an object off a high shelf drew a chair below the shelf to stand upon. Anger was expressed in the 10th month, shame and pride in the 19th.

Between the 10th and 11th month the first perception of causality was observed. Thus on the 319th day the child was beating on a plate with a spoon and accidentally found that the sound was damped by placing the other hand upon the plate; it then changed its hands and repeated the experiment. Similarly at 11 months it struck a spoon upon a newspaper, and changed hands to see if this would modify the sound. In some children, however, the perception of causality to this extent occurs earlier. The present writer has seen a boy when exactly 8 months old deriving much pleasure from striking the keys of a piano, and clearly showing that he understood the action of striking the keys to be the antecedent required for the production of the sound.

The third part of the book is concerned, as already stated, with the development of the Understanding. Here it is noticed that memory and recognition of the mother's voice occurs as early as the second month; at 4 months the child cried for his absent nurse; and at 18 months he knew if one of ten toy animals were removed. In Preyer's opinion—and we think there can be no question of its accuracy—the intelligence of a child before it can speak a word is in advance of that of the most intelligent animal. He gives numerous examples to prove that a high level of reason is attained by infants shortly before they begin to speak, and therefore that the doctrine which ascribes all thought to language is erroneous.

Highly elaborate observations were made on the development of speech, the date at which every new articulate sound was made being recorded. The following appear to us the results under this head which are most worth quoting.

Instinctive articulation without meaning may occur as early as the 7th week, but usually not till the end of the first half year. Tones are understood before words, and vowel sounds before consonants, so that if the vowel sounds alone are given of a word which the child understands (13 months), it will understand as well as if the word were fully spoken. Many children before they are six months old will repeat words parrot-like by mere imitation, without attaching to them any meaning. But this "echo-speaking" never takes place before the first understanding of certain other words is shown—never, *e.g.* earlier than the 4th month. Again, all children which hear but do not yet speak, thus repeat many words without understanding them, and conversely, understand many words without being able to repeat them. Such facts lead Prof. Preyer to suggest a somewhat elaborate *schema* of the mechanism of speech, both on its physiological and psychological aspects; but this *schema* we have not sufficient space to reproduce.

Although the formation of ideas is not at first, or even for a considerable time, dependent on speech (any more than it is in the case of the lower animals), it constitutes the condition to the learning of speech, and afterwards speech reacts upon the development of ideation. A child may and usually does imitate the sounds of animals as names of the animals which make them long before it can speak one word, and, so far as Preyer's evidence goes, interjections are all originally imitative of sounds. Children with a still very small vocabulary use words metaphorically, as "tooth-heaven" to signify the upper gums, and it is a mistake to suppose that the first words in a child's vocabulary are invariably noun-substantives, as distinguished from adjectives or even verbs. As this statement is at variance with almost universal opinion, we think it is desirable to furnish the following corroboration. The present writer has notes of a child which possessed a vocabulary of only a dozen words or so. The only properly English words were "poor," "dirty," and "cook," and of these the two adjectives, no less than the noun-substantive, were always appropriately used. The remaining words were nursery words, and of these "ta-ta" was used as a verb meaning to go, to go out, to go away, &c., inclusive of all possible moods and tenses. Thus, for instance, on one occasion, when the child was wheel-ing about her doll in her own perambulator, the writer stole away the doll without her perceiving the theft. When she thought that the doll had had a sufficiently long ride, she walked round the perambulator to take it out. Not finding the doll where she had left it she was greatly perplexed, and then began to say many times "poor Na-na, poor Na-na," "Na-na ta-ta, Na-na ta-ta"; this clearly meant—Poor Na-na has disappeared. And many other examples might be given of this child similarly using her small stock of adjectives and verbs correctly.

According to Preyer, from the 1st week to the 5th month the only vowel-sounds used are *ü* and *a*. On the 43rd day he heard the first consonant, which was *m*, and also the vowel *o*. Next day the child said *ta-hu*, on the 46th day *gö*, *örö*, and on the 51st *arra*. All the vowel sounds were acquired in the 5th month. We have no space to go further into the successive dates at which the remaining consonants were acquired. In the 11th month the child first *learnt* to articulate a certain word (*ada*) by imitation, and afterwards repeated the taught word spontaneously. The first year passed without any other indication of a connection between articulation and ideation than was supplied by the child using a string of different syllables (and not merely a repetition of the same one) on perceiving a rapid movement, as any one hurriedly leaving the room, &c.; but this child nevertheless understood certain words (such as "Handchen geben") when only 52 weeks old. Inefficient attempts at imitative speaking precede the accurate attempts, and at 14 months this inefficiency was still very apparent, being in marked contrast with the precision whereby it would imitate syllables which it could already say; the *will* to imitate all syllables was present, though not the *ability*. At the beginning of the 14th month on being asked—"Wo ist dein Schrank?" the child would turn its head in the direction of the cupboard, draw the person who asked the question towards it (though the child could not then walk); and so with other objects the names of which it knew. During the next month the child would point to the object when the question was asked, and also cough, blow, or stamp on being told to do so. In the 17th month there was a considerable advance in the use of sign-language (such as bringing a hat to the nurse as a request to go out), but still no words were spoken save *ma-ma*, *pa-pa*, &c. In the 20th month the child could first repeat words of two unlike syllables. When 23 months old the first evidence of judgment was given; the child having drunk milk which was too hot for it, said the word "heiss." In the 63rd week this word had been learnt in imitative speaking, so it required 8½ months for it to be properly used as a predicate. At the same age on being asked—"Where is your beard?" the child would place its hand on its chin and move its thumb and fingers as if drawing hair through them, or as it was in the habit of doing if it touched its father's beard; this is evidence of imagination, which, however, certainly occurs much earlier in life. At the close of the second year a great advance was made in using two words together as a sentence—*e.g.* "home, milk," to signify a desire to go home and have some milk. In the 1st month of the 3rd year sentences of three or even four words were used, as "Papa, pear, plate, please." Hitherto the same word would often be employed to express several or many associated meanings, and no words appeared to have been entirely invented. The powers of association and inference were well developed. For instance, the child received many presents on its birthday, and being pleased said "bursta" (= Geburtstage); afterwards when similarly pleased it would say the same word. Again, when it injured its hand it was told to blow upon it, and on afterwards knocking its head it blew into the air. At this age also the power of making propositions advanced considerably, as was shown, for instance, by the following sentence on seeing milk spilt upon the floor—"mime atta teppa papa oï," which was equivalent to "Milch fort (auf den) Teppich, Papa (sagte) pfui!" But it is interesting that at this age words were learnt with an erroneous apprehension of their meanings; this was particularly the case with pronouns—"dein Bett," for example, being supposed to mean "das grosse Bett." All words which were spontaneously acquired seemed to be instances of onomatopæia. Adverbs were first used in the 27th month, and now also words which had previously been used to express a variety of associated or generic meanings, were discarded for more specific ones. In the 28th month prepositions were first used, and questions were first asked. In the 29th month the chief advance was in naming self with a pronoun, as in "give me bread"; but the word "I" was not yet spoken. When asked—"Wer ist mir?" the child would say its own name. Although the child had long been able to say its numerals, it was only in this month that it attained to an understanding of their use in counting. In the 32nd month the word "I" was acquired, but still the child seemed to prefer speaking of itself in the third person.

The long disquisition on the acquirement of speech is supplemented by a chapter conveying the observations of other writers upon the same subject. This is followed by an interesting chapter on the development of self-consciousness, and the work concludes with a summary of results. There are also lengthy appendices on the acquirements of correct vision after surgical operations by those who have been born blind, and on the mental condition of uneducated deaf mutes; but we have no space left to go into these subjects, Enough, we trust, has been said to show that Prof. Preyer's laborious undertaking is the most important contribution which has yet appeared to the department of psychology with which it is concerned.

GEORGE J. ROMANES

SCLATER'S "JACAMARS AND PUFF-BIRDS"

A Monograph of the Jacamars and Puff-birds, or Families Galbulidæ and Bucconidæ. By P. L. Sclater, F.R.S., &c. 1 vol. roy. 4to, half-bound Morocco. (London: Dulau and Co., 1882.)

THE completion of another illustrated Ornithological Monograph is an event worthy of record in the columns of NATURE, although the subjects of it are, perhaps, of somewhat limited interest to the scientific world in general. "Jacamars" and "Puff-birds" are, no doubt, well-known groups to the ornithologist, but confined as they are in life to the dense forests of South and Central America, and invisible to most persons even as inhabitants of our Zoological Gardens, their names certainly do not convey any very definite ideas to the uninitiated. We will, therefore, endeavour to explain in a few words what "Jacamars" and "Puff-birds" are.

The Jacamars or family "Galbulidæ" of naturalists form a small group of birds somewhat resembling the kingfishers in general external structure, but with zygodactyle feet, *i.e.* the toes placed two before and two behind, and with brilliant metallic plumage. They inhabit the forests of America from Guatemala to Southern Brazil, and are generally met with perched upon the outer branches of the trees, and capturing their insect-prey by short flights, after which they return to their former station—like our common flycatcher. The known Jacamars are nineteen in number, referable to six genera. Of all of these species and, in most cases, of both sexes of them, full life-sized figures are given in the present work, from the artistic pencil of M. Keulemans. Of the accompanying letterpress it need only be said that it embraces an account of all the particulars yet known respecting these birds, which at the present time in several cases amounts to very little, and in nearly every instance leaves much to be done before we can be said to have anything like a perfect knowledge of them.

Of the closely allied family of the Bucconidæ or Puff-birds nearly the same may be alleged as regards our knowledge of their life-history. The dense wilds of South America need many further years of constant exploration and minute investigation before such particulars can be duly recorded. The Puff-birds are a more numerous group than the Jacamars. Mr. Sclater recognises forty-four species of the family Bucconidæ, divisible into seven genera. These are treated in exactly the same way as the Jacamars, and illustrated in a similarly artistic manner. No one we think will be likely to find fault with the life-like way in which the artist has represented the various species. Even as a picture-book the Jacamars and Puff-birds form a most attractive volume.

The work now completed is uniform in size and style with Mr. Sharpe's "Kingfishers," Messrs. Marshalls' "Barbets," and Capt. Shelley's "Sun-birds," and forms one of the same series of illustrated Ornithological Monographs prepared by different Members of the British Ornithologists' Union. Nor is the series likely to end here, for we are informed that Mr. Dresser has a companion volume on the "Bee-eaters" in a very forward state, and that other similar works are already projected.

OUR BOOK SHELF

An Illustrated Essay on the Noctuidæ of North America, with "a Colony of Butterflies." By Augustus Radcliffe Grote, A.M., &c. 8vo. (London: Van Voorst, 1882.)

THE main feature in this beautifully-got-up little book consists in the four coloured plates, which depict forty-five of some of the most charming insects of the family of moths, to which the author has devoted his special attention. The species have all been previously described, but all those who have studied *Lepidoptera* know that it is often practically impossible to identify these insects from descriptions only, and will feel grateful to Mr. Grote for the help afforded by these plates, which are very beautiful. They will likewise thank him for identifying many of the North American species "described" by Walker, according to the types in the British Museum. This process of identifying Walker's types appears likely to occupy the attention of entomologists at least to the end of the present century. The long introductory "Preface" (which forms more than a third of the entire text, and is paged continuously with it) is open to the suggestion of being too rambling in character, and of containing general matter, and polemics, foreign to the title of the book. The chapter on structure and literature will prove very useful. Here, as in the "Preface," a want of concentration in the remarks is observable. The supplementary "Colony of Butterflies" is the most successful part of the work from a literary (and perhaps also from a scientific) point of view. A curious butterfly of a genus of boreal proclivities (*Œneis semidea*) inhabits the summit of Mount Washington (in the White Mountains), above an elevation of 5600 feet to the summit (6293 feet), and is there isolated. Naturally this is associated with the glacial theory (and it might find many parallels in the Alps of Europe, &c.), and the author has contrived to give us a very instructive chapter on this subject, but we do not gather how he came to know that the "colony" first settled "about one hundred thousand years ago."

Six Months in Persia. By Edward Stack. 2 vols. (London: Sampson Low and Co., 1882.)

NOTWITHSTANDING some serious drawbacks, this work will be accepted as a useful contribution to our knowledge of a country about which much ignorance still prevails. It embodies the results of a journey made through the central provinces of Persia last year by a promising member of the Bengal Civil Service *en route* for England. By departing, wherever possible, from the beaten tracks along the main highways between the Persian Gulf and the Caspian, the traveller has succeeded in collecting much useful information regarding many districts about which very little was hitherto known. But the journey having been specially undertaken at some personal inconvenience in the interests of geographical research, it seems all the more surprising that more forethought was not shown by the explorer in qualifying himself for the task. A little time devoted to a study of the broad principles of geology and botany, as well as to the simple methods of taking altitudes, would have enabled him to turn his opportunities to far better account. As it is, these branches of science are almost entirely neglected, and the space which might have been usefully occupied, with such subjects, is too often sacrificed to trivial details irritating to the reader, and swelling the work to undue proportions. As Damávand was ascended, it would have been more satisfactory, for instance, to have checked the altitude of that famous cone (18,600 feet), taken some years ago by the Russian Caspian Survey, than to be told that at one place there were two little shrines "with small blue domes, date groves and water," at another a ruined mud fort, further on many other ruined mud forts, that one man asked him "endless questions about England which I answered to the best of my ability for the space of two hours," that another "gave me a good dinner," and so on for page after page. Nevertheless some important work, chiefly of a topographical character, was carried out and carefully recorded in the region between Shiraz and Lar, in the Saidábád and Karmán districts, in the neighbourhood of Yazd, and especially in the Bakhtari highlands west of Isfahán. Here the orography and hydrography of the Chahar Mabal and Zarda-kuh uplands were carefully surveyed, and a fresh route explored thence northwards to Gilpaigan. As, according to the latest accounts, the Bakhtari hillmen are again threatening to give trouble to the Prince-Governor of Isfahán, this information may soon prove valuable. These fierce nomads are of the same race and speech as the Kurds, who committed such havoc in the Urmia district last year, and who seem to be again preparing for fresh raids on the Turco-Persian frontier between Azerbaiján and Armenia.

In every respect the most interesting and valuable part of the work are the concluding chapters of vol. ii., in which all the fresh geographical materials are conveniently summed up, the land revenue system of Persia dealt with probably for the first time in a really satisfactory manner, and the present condition of the country made the subject of some opportune remarks. It is pleasant to learn that this venerable monarchy, so far from being "played out," is even beginning to show signs of renewed vitality. The famine-stricken districts are gradually recovering, the peculiar underground system of irrigation is being largely extended, brigandage has been almost everywhere suppressed, the governors are beginning to show some regard for the interests of the people, while many will perhaps be surprised to hear that the people themselves are, on the whole, more comfortable, better clad, and better fed than the Indian rayats. There is, of course, "much to be done in the way of governing and reducing things to order;" but notwithstanding much maladministration and many local grievances, "the progress made by Persia within the last ten years is unmistakable."

The work is supplied with a series of excellent sectional maps of the regions traversed by the explorer. But there is neither index nor a table of contents beyond the briefest chapter-headings. The stages, however, along the routes are in all cases carefully recorded, with their distances and time occupied in covering the ground.

A. H. KEANE

Notes on Chemical Calculations, with Examples, for use in the Leys School. By A. Vinter, M.A. (Batley: J. S. Newsome, 1882.)

THE selection of calculations contained in this little book, while exhibiting nothing new, is satisfactory; the notes, in so far as they are explanatory of the calculations, are clear, and to the point, but when they deal with such subjects as atoms, molecular weights, and equivalency, they become sadly confused; on these points they must, we are afraid, be very misleading to the boys who make use of this book in the Leys school.

A Pocket Guide to British Ferns. By Marian S. Ridley. (London: Bogue, 1881.)

MISS RIDLEY'S book merits its title; for it is of a most convenient size for the pocket. Whether a new book on British ferns was needed may fairly be doubted; but this little volume will be useful to many beginners. The characters of each fern are given in tabular form, each occupying a page; and the principal points of distinction are clearly brought out.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

A Meteorological Spectroscope

As a considerable amount of interest seems to have been awakened lately in meteorological spectroscopy, it may be of service to observers to call their attention to a form of pocket spectroscope specially adapted for this purpose which Mr. Adam Hilger, of 192, Tottenham Court Road, prepared for me some months ago. The compound triple prism of flint glass is mounted as nearly as possible at the minimum angle of deviation for "C." We thus obtain a much better view of the red end of the spectrum than with the ordinary pocket spectroscope. Mr. Hilger has also managed to secure an increased dispersion, which, with very perfect definition, enables me to see the lines in the so-called "rain-band" at "D" with great ease.

Besides the ordinary achromatic object-glass between the adjustible slit and the prisms, the spectroscope is fitted with a telescope, *i.e.* a sliding tube carrying a lens, or second object-glass, in front of the slit—proposed by Mr. Lockyer—to bring the light from external objects to a focus on it. By this means one is able to differentiate, or localise, the spectra of different parts of the sky. I feel sure that the use of the telescope would prevent people falling into some of the mistakes one sees in publications about rain-band spectroscopy.

September 14 J. F. D. DONNELLY

The New Comet

ON Sunday morning, the 17th inst., at 10.45 a.m., I found a bright comet near the sun. The nucleus was bright, stellar in appearance; the tail was about 4′ long, and brightest at the outside edges, giving a double appearance. The direction of the comet was to the centre of the sun. The comet preceded the sun's centre at 10.59 by 6m. 50s., at 12h. 0m. by 5m. 44s. The distance from the sun's limb on the parallel was at 11h. 10m, 18′ 8″ (of arc), and at 12h. 6m., 13′ 4″.

I hoped to get more and better measures, but the sky overcast, and with the exception of a short time on Monday morning, when I looked but did not see, the comet has remained so.

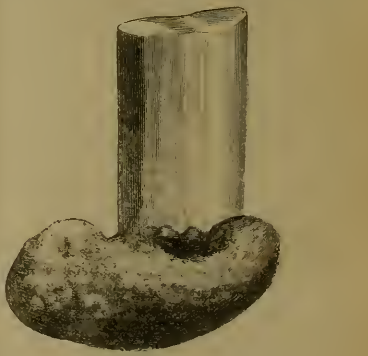
I used a helioscope of six inches' aperture.

Ealing, September 19 A. A. COMMON

Contact Makers of Delicate Action

I HAVE allowed an error to creep into the sectional elevation of the contact-maker described in your last issue. The bent wire merely *dips* into the capsule at D, and is separate from the wire, which passes up the tube. This latter wire merely forms part of the circuit, being connected with the terminal as shown in the plan. It should be noted that the plug K is only inserted when the contact-maker is being moved about. Except when this is the case, the mercury passes freely through the opening at M, and nothing but the *friction of mercury* resists the motion of the wire.

Some remarks made in the discussion on the paper have led me to carefully examine the end of the platinum wire dipping into the mercury at D. It is shown (highly magnified) in the annexed figure. This end being softened, and no doubt brought to a welding state by the heat, of which the spark is the visible evidence, has, in rapidly beating upon the mercury, been apparently hammered into this shape. The nodules upon it are probably those referred to in books on chemistry as due to the expulsion of occluded hydrogen. The result shown in the figure, produced with a strong current (15 Groves cells) and a small wire, could in practice be easily prevented.



End of Platinum Wire.

H. S. HELE SHAW

University College, Bristol, September 15

Bobbers

IN his well-known account of the habits of the Pearly Nautilus, Rumphius (D'Amboinsche Rariteitkamer, door G. E. Rumphius, Amsterdam, 1705, p. 61) states that the animal crawls sometimes into the hoop nets set for fish or "bobbers." For a long time I have been unable to discover the meaning of the word "bobbers." It occurs in no Dutch dictionary. I inquired from several Dutch friends without success, and an appeal to *Notes and Queries* was similarly without result. On visiting Leiden this summer I asked again about the word, and my friend, Prof. Serrurier, promised to find out about it for me. He now writes that "bobber" is a Dutch mutilation of the Malay word *boeboe*, meaning a hoop-net, so that Rumphius merely adds the Malay term for the hoop-net to his statement, and does not mention some other kind of trap besides this, in which nautilus is to be caught as I had expected. This matter may seem scarcely worth troubling the readers of NATURE with, but Nautilus is so important a form, so little is known about its habits, and naturalists so eagerly look forward to the day when it shall be caught somewhere in numbers, and its developmental history worked out, that every statement as to possible modes of trapping it is of importance. It is just possible that suitably baited lobster pots or hoop-nets, used in depths of 100 fathoms or thereabouts, might be found efficacious.

H. N. MOSELEY

PROFESSOR HAECKEL IN CEYLON[1]

V.

THE long account of his six week's stay in Belligam (or Bella Gemma, "schöner Edelstein" as, in defiance of etymology he delights to call it) contributed by Professor Haeckel to the September number of the *Deutsche Rundschau* will be disappointing only to those who imagine that the theoretical and scientific results of such a visit can be analysed, combined and presented to the public within the compass of an article and in a sufficiently popular form to interest the readers of a magazine devoted to general literature.

All, whether scientific or not, will find interest in the graphic and spirited account of Belligam, its Rest-House, its inhabitants, and the surrounding nature, animate and inanimate, which is here presented to us. The Rest-House keeper with an unpronounceable Singhalese name Prof. Haeckel christened "Socrates," from his striking resemblance to the bust of that great philosopher, heightened by the sententious maxims with which he flavoured his somewhat long-winded discourses. The Professor's devoted attendant, a handsome Rodiya boy, whose Singhalese name, Gama-Meda, was classicised by him into "Ganymede," is described in detail with an affection that rises into poetical fervour. The picture presented by this poor outcast, the springs of whose heart were first opened by the kind-hearted foreigner whom it became the delight of his life to serve, is charming. "Who so happy as Ganymede when summoned for an expedition to the woods or the shore for painting and collecting, hunting and shooting? When, on such occasions, I allowed him to carry the paint-box or the photographic camera, or to sling the gun or the botanical case over his shoulder, he would stride after me, his face aglow with delight, looking proudly around on the wondering villagers, to whom such favour shown to a Rodiya was utterly incomprehensible.

"To Ganymede's unwearied skill and zeal I owe the most highly prized objects of my collection. With the sharp eye, the cunning hand, and the flexible agility of all Singhalese youths, he could catch the fish as it swam, the butterfly as it flew, and would bound into the thickest jungle, or climb the loftiest trees like a cat, in search of the prey that had fallen to my gun."

Another pleasant figure, standing out sharp and clear among Professor Haeckel's memories of Belligam, is that of the second chief, or headman of the village, the Arachy Abayawira. His superior character and acquirements were known to the government agent of the southern province, who had given the Professor a special introduction to him.

"I found the Arachy," he says, "an unusually intelligent and enlightened man, of about forty years of age, with a circle of interests and an amount of knowledge far beyond those of his fellow-countrymen in general. The prevailing stupidity, laziness, and indifference of the Singhalese gave place in him to a lively interest in education, and a genuine wish to extend its advantages to all within the range of his influence. He spoke English fairly well, and expressed himself with a natural good sense, and a clearness of judgment which often surprised me.

"Indeed, the Arachy might claim the title of a philosopher, in a higher sense than that of old Socrates at the Rest House, and I recall with lively pleasure our many and earnest conversations on subjects the most varied and comprehensive. He was free from the superstition and fear of evil spirits which universally prevail among his Buddhist fellow-countrymen, and with open eyes for the wonders of Nature and their explanation by natural laws; he had worked his own way to the position of a free-thinker, prepared to receive with delight the explanations of many of the riddles of Nature which my better knowledge enabled me to give him. I seem to see him still, a fine, dignified, bronze-coloured figure, with regular expressive features, and an eye that lighted up with intelligence as I instructed him on some of the phenomena of Nature; and I seem still to hear his gentle, vibrating voice, as he modestly and respectfully asked my explanation of this or that problem which had puzzled him. The highest and most amiable qualities of the Singhalese national character, a gentle and impressionable temper, and a natural intelligence were developed in the Arachy in the most attractive degree; and when, looking back, I seek to repeople my verdant Paradise with the slender bronze figures of its inhabitants, the images of the Arachy and Ganymede rise before me as their ideal types."

The section of his article headed by the Professor "A Zoological Laboratory in Ceylon," will be read by his fellow collectors, and, indeed, by all who appreciate perseverance in spite of obstacles, and entire devotion to a scientific object, with feelings of lively sympathy mingled with admiration. The difficulties arising from want ot furniture and appliances, from the absence of all skilled assistance, from destructive insects, and above all, from the climate of Ceylon, were such as would have daunted any less ardent believer in the cause for which he laboured. We wish that we had space to extract at length for the benefit of youthful experimenters the Professor's account of his improvised tables, cabinets, and shelves, and of the semi-despairing resignation with which, after a long day's collecting, he would empty the contents of his jars and glasses to find nine-tenths of his treasures dead before their time from the heat and moisture of the air, and useless as specimens. Another infliction which he seems to have borne with admirable patience consisted in the intrusive curiosity of the natives, who crowded uninvited into his work-room, or thronged round him on his return from a fishing expedition, often causing him to lose the precious minutes which would have saved some of his half dead specimens. The Arachy's explanation that all the white sand and queer little fishes contained in the glasses and jars were to be used to increase knowledge in the world was received with derision by the villagers, the more simple of whom believed that the stranger was inventing a new dish of curry, while the wise-heads looked upon him as a European madman. The want of glass windows was another serious drawback to the preservation of the collection when once safely housed. The green wooden jalousies, which are universal in Ceylon, kept the room too dark for work with the microscope, while admitting an amount of wind and dust (not to mention the more serious incursion of hosts of insects) very detrimental to the specimens and instruments. All these hindrances and others notwithstanding, Prof. Haeckel

---

[1] Continued from p. 390.

amassed at Belligam materials for the study of a lifetime, and even obtained some consolation from finding confirmation of the fact which has recently been strikingly demonstrated by the *Challenger* expedition, namely, that life does not exist in anything like the same diversity of form in different oceans as on different continents; and that in essential features the marine fauna of one tropical coast differs very little from that of another. The account which Prof. Haeckel gives at some length of the daily routine of his life in Belligam is interesting. The Professor begins by congratulating himself on this accident of position as affording him twelve clear working hours in the day.

"I rose," he says, "regularly before the sun, and had enjoyed my first morning bath by the time he showed himself from behind the palm-woods of Cape Mirissa, exactly opposite my Rest-House. As I stepped on to the verandah to enjoy the sudden awakening of the glorious day, I was sure of finding Ganymede with an open cocoanut of sweet, cool milk, than which there could be no more refreshing morning drink. William, in the meantime, was shaking my clothes free from the millipeds, scorpions, and other insects, which had crawled into their folds during the night. Then came Socrates and served me with tea, accompanied by a bunch of banana fruit and the maize bread of the country. My usual beverage, coffee, is, strange to say, so bad in Ceylon as to be undrinkable, principally because the extreme moisture of the climate prevents the berry from drying properly.

"At seven o'clock my boatmen appeared to carry down my nets and glasses for the daily canoe expedition. This lasted from two to three hours, and on my return I busied myself in disposing my captures in glasses of different sizes, and saving such as could be saved among the few survivors. The more important specimens were microscoped and drawn at once. Then I had my second bath, and at eleven o'clock appeared my so-called 'breakfast,' consisting chiefly of curry and rice. The rice was simply boiled, but in the preparation of the curry my old cook, Babua, exerted all the ingenuity with which nature had endowed his diminutive brain to present me with a fresh combination every day. Sometimes the curry was 'sweet,' sometimes 'hot;' sometimes it appeared as an undefinable *mixtum compositum* of vegetables, sometimes as a preparation of the flesh of various animals. Babua seemed to divine that as a zoologist I was interested in every class of animal life, and that he could not do better than turn my curry into a sort of daily zoological problem. . . . He was apparently a staunch upholder of the theory of the near relationship of birds and reptiles, and held it to be immaterial what particular species of *Saurian* were prepared for the table.

"Fortunately for my European prejudices, I only became acquainted by degrees with the zoological variety of my daily dish of curry; usually not until I had swallowed a considerable portion of it in silent resignation. . . . My great resource as an article of diet was the fruit which abounded at every meal and made up for all that I suffered from Babua's curries. Next to the bananas of every variety, of which I consumed several at every meal, my standing dessert consisted of mangoes (*Mangifera indica*), egg-shaped green fruit, from three to six inches long; their cream-like golden pulp has a faint but distinct aroma of turpentine. The fruit of the passion-flower (*passiflora*) was very pleasant to my taste, reminding me of the gooseberry. I was less pleased with the renowned custard-apple, the scaly fruit of the *Annona squamosa*, and with the Indian almond, the hard nut of the *Terminalia catappa*. There are singularly few apples and oranges in Ceylon; the latter remain green, and are sour and not juicy; but the want of cultivation is doubtless chiefly answerable for the inferiority of this and other fruits; the Singhalese are far too easy-going to make any progress in horticulture. Refreshed with my modest repast, I employed the hot hours of mid-day—from twelve to four o'clock—in anatomical or microscopic work, in making observations and drawings, and in the preservation and storing of my collected objects. The evening hours, from four to six o'clock, were generally occupied with some lovely country excursion; sometimes I made a water-colour sketch, sometimes I sought to perpetuate one of the beautiful views in photography. Now and then I shot apes and birds in the woods, or collected insects and snails, or hunted among the coral reefs on the shore, adding many curious objects to my collection. Richly laden, I return to the Rest House an hour or less before sunset, and worked for another hour at the preservation and arrangement of my specimens. At eight o'clock, my second chief meal, or dinner, was served. The *pièce de résistance* at this was again the inevitable curry and rice, followed sometimes by a fish or a crab, which I enjoyed immensely, and then by some dish composed of eggs or meal, and finishing again with delicious fruit. . . . The important question of 'what to drink,' seemed likely at first to prove a difficult one. The ordinary drinking water of the lowlands of Ceylon is considered very bad and unwholesome, the highlands, on the contrary, being rich in springs of the purest and freshest water. The great rains which fall daily on the island bring down a mass of mineral and vegetable deposit into the rivers and the stagnant water of the lagoons is not unfrequently in communication with them. It is not customary to drink the water unless boiled or made into tea, or with the addition of claret or whisky. My friend Scott had given me an abundant supply of the last-named beverage, but on the whole, I found no drink so pleasant and refreshing as well as wholesome, as the fresh milk of the cocoa-nut.

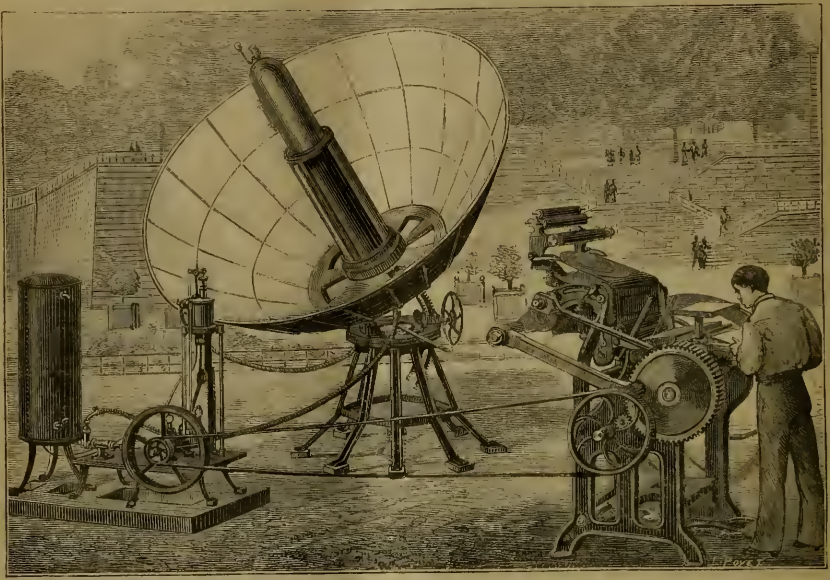
"My frugal dinner at an end, I usually took a solitary walk on the shore, or delighted my eyes with the sight of the illumination of the palm woods by myriads of fire-flies and glow-worms. Then I made a few entries in my note-book, or tried to read by the light of a cocoa-nut oil lamp. But I was generally quite tired enough to go to bed soon after nine o'clock, after another careful shaking of the clothes for the expulsion of scorpions and millipeds.

"The great black scorpion (nearly a foot long) is so common in Ceylon that I once collected half a dozen in the course of an hour. Snakes exist also in great numbers. Slender green tree-snakes hang from almost every bough, and at night the great rat-snake (*Coryphodon Blumenbachii*) hunts rats and mice over the roofs of the huts. Although they are harmless and their bite not poisonous, it is by no means a pleasant surprise when one of these rat-snakes, five feet long, suddenly drops through a hole in the roof into one's room, occasionally alighting on the bed.

"On the whole, however, my nights in Belligam were but little disturbed by animal intruders, although I was often kept awake by the howling of jackals and the uncanny cry of the Devil-bird (a kind of owl, *Syrnium Indrani*) and other night-birds. The bell-like cry of the pretty little tree-frogs which make their dwelling in the cups of large flowers, acted rather as a slumber song. But I was far oftener kept awake by the whirl of my own thoughts, by the recollection of the many events of the past day, and the anticipation of that which was to come. A brilliant succession of lovely scenes, of interesting observations and varied experiences mingled in my brain with plans of fresh enterprise and new discoveries for the morrow."

A SOLAR PRINTING PRESS

IT was mentioned in a recent number of this journal that a printing press worked by solar heat had been exhibited in the Tuileries Garden in Paris on the occasion of a *fête*. We are enabled to give some particulars of the contrivance from an account published in *La Nature*, from which the accompanying illustration is borrowed by permission of the editor. The solar generator was one of those devised by M. Abel Pifre, who has improved in some points on the original invention of M. Mouchot. The insolator, shown in the middle of the picture, measured 3·50 m. diameter at the aperture of the parabolic mirror. It was set up in the garden, near the large basin, at the foot of the flight of steps of the Jeu de Paume. The steam from the boiler placed in its focus was utilised by means of a small vertical motor (shown on the left), having a power of 30 kilogrammetres, which actuated a Marinoni press (on the right). Though the sun was not very ardent, and the radiation was hindered by frequent clouds, the press was worked with regularity from 1 p.m. till 5.30 p m, printing on an average 500 copies an hour, of a journal specially composed for the occasion, viz., the *Soleil Journal*. This result, though not indicating a revolution in the art of printing, may enable one to judge of the services these *insolators* may render in climates with a radiation more powerful and constant.



A Solar Printing Press.

NOTES ON THE AYE-AYE OF MADAGASCAR

HAVING recently passed through that part of Madagascar which is the habitat of the Aye-aye, and having made careful inquiries from the Malagasy respecting the habits of this strange creature in its native haunts, I have thought that the information gained might be of interest to the readers of NATURE, and therefore note down the result of my inquiries.

The Aye-aye lives in the dense parts of the great forest that runs along the eastern border of the central plateau of the island, but only in that part of it which separates the Antsihànaka province from that of the Bétsimisàraka, and which is about twenty-five miles from the east coast, in latitude 17° 22′ S., or thereabouts. Possibly there are other parts of the country where the Aye-aye is found; but so far as my knowledge extends—and I have made inquiries in different parts of the island—this is the only region where the creature finds its home. In Carpenter's "Zoology" the Aye-aye is said to be "very rare in its native country"; and Mr. Gosse in one of his books conjectures that it is probably nearly extinct; but, from what I gathered from the natives, it seems to be pretty common, its nocturnal habits and the superstitious awe with which it is regarded (and of which I shall presently speak), accounting for its apparent rarity.

The native name of the animal is Haihay (Hīhī); but this is not derived from the "exclamations of surprise" which the natives "exhibited at the sight of an unknown animal," but is simply onomatopœetic, the creature's call being "Haihay, Haihay." The animal, as is well known, is nocturnal in its habits, prowling about in pairs—male and female. It has but one young one at a birth. It builds a nest of about two feet in diameter, of twigs and dried leaves, in the dense foliage of the upper branches of trees. In this it spends the day in sleep. The nest is entered by a hole in the side.

The teeth are used in scratching away the bark of trees in search of insects, and the long claw in dragging out the prey when found. A white insect called *Andraitra* (possibly the larva of some beetle) seems to form its chief food. I was told that it frequently taps the bark with its fore feet, and then listens for the movement of its prey beneath, thus saving itself useless labour. It does not flee at the sight of man, showing that for generations it has not been molested by him; which is indeed true, as the following will show. The natives have a superstitious fear of the creature, believing that it possesses some supernatural power by which it can destroy those who seek to capture it, or do it harm. The consequence of this is that it is with the greatest difficulty one can obtain a specimen. With most of the people no amount of money would be a sufficient inducement to go in pursuit of the creature, "because," say they, "we value our lives more than money." It is only a few of the more daring spirits among them who, knowing the *ódiny, i.e.* the secret by which they can disarm it of its dreaded power, have the courage to attempt its capture. Occasionally it is brought to Tamatave for sale, where it realises a good sum. Now and then it is accidentally caught in the traps which the natives set for lemurs, but the owner of the trap, unless one of those versed in the Aye-aye mysteries, who knows the charm by which to counteract its evil power, smears fat over it, thus securing its forgiveness and goodwill, and then sets it free. The story goes that occasionally, when a person sleeps in the forest, the Aye-aye brings a pillow for him—if a pillow for the head, the person will become rich; if for the feet, he will shortly succumb to the creature's fatal power, or at least will become bewitched. Such is the account which the natives give of the curious *Cheiromys Madagascariensis.*

R. BARON,
L.M.S. Missionary

Antananarivo, Madagascar, April, 1882

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

(FROM A CORRESPONDENT)

THIS body held its thirty-first annual meeting at Montreal during the week beginning August 23. under the presidency of Dr. J. W. Dawson, LL.D., F.R.S. Ample accommodation for the Association was found in the buildings of McGill University, and the attendance was very large, 939 persons having been registered. Besides the American and Canadian Fellows and Members of the Association, there were several guests from abroad, among them, Dr. W. B. Carpenter, Dr. J. H Gilbert, Prof. Wiltshire, and Dr. Phené, of London; Dr. Samuel Haughton and Prof. Fitzgerald from Dublin, together with Messrs. Szabo of Budapest, Kowalesky of Moscow, and König of Paris, all of whom made communications to the Association.

After the opening ceremonies on the morning of the first day, the nine sections into which the Association is now divided listened to the addresses of their respective vice-presidents. These sections are as follows:—A. Mathematics and Astronomy; B. Physics; C. Chemistry; D. Mechanical Science; E. Geology and Geography; F. Biology; G. Histology and Microscopy; H. Anthropology; and I. Economic Science and Statistics. According to custom, the retiring president of the Association, Dr. George J. Brush, gave his address on the first Wednesday evening, taking for his theme, The Progress of American Mineralogy. This was followed by a reception of the Members of the Association by the Local Committee, its chairman, Dr. Sterry Hunt, acting as host. On Thursday evening the New Redpath Museum of Natural History, lately erected at a cost of 100,000 dollars by Mr. Peter Redpath, and by him presented to the University, was formally opened with addresses by Mr. James Hall and Dr. W. B. Carpenter, a reception being given therein by the President and Mrs. Dawson to the Association and others. Thursday and Friday were devoted to the work of the sections, but Saturday was given to excursions to Ottawa and to Quebec, in both of which cities entertainments were provided by the citizens. Public lectures were given on Monday and Tuesday evenings by Dr. W. B. Carpenter and Prof. Meville Bell, on The Temperature of the Deep Sea, and On Visible Speech. The reading of papers, however, occupied both the morning and afternoon of these days, and of Wednesday the 30th, on the evening of which day the closing meeting was held, the Association adjourning to meet next August at Minneapolis, in Minnesota, under the presidency of Dr. C. A. Young, of Princeton, New Jersey. The number of papers entered was 256, of which nearly all were read either at length or in abstract, and will be published in the Proceedings.

In addition to the excursions already noticed was one provided by the Harbour Commissioners, and another through South-eastern Canada, to Lake Memphramagog at the close of the meeting. An entertainment in the galleries of the Montreal Fine Art Association should also be mentioned, and various garden parties and *fêtes* by the citizens, who vied with each other and with the railways and steamboat lines in their hospitalities to the members of the Association.

Mention should here be made of a Handbook of Montreal, an illustrated volume of 159 pages, prepared for the meeting by Mr. S. E. Dawson, of the Local Committee, and presented to the members. This little book is remarkable for its excellent historical introduction, and also for a valuable coloured geological map of the environs of the city, prepared by Dr. Sterry Hunt.

After the meeting a small party, including Dr. Carpenter, Prof. Wiltshire, and Dr. Szabó, were conducted by Dr. J. W. Dawson and Dr. Sterry Hunt to the remarkable locality of *Eozöon Canadense,* near St. André Avellin, among the Laurentide Hills, not far from the City of Ottawa.

PROFESSOR PLANTAMOUR

THE daily journals notify the decease on the 7th instant, at Geneva, of Prof. Plantamour, for many years Director of the Observatory and Professor of Astronomy in the University of that city.

Emile Plantamour was born at Geneva in 1815, and received his early education in the old college founded by Calvin. He entered the Geneva Academy in 1833, where he became a pupil of Alfred Gautier, then in the Chair of Astronomy, and on graduating, adopted this science as his profession. He studied two years at Paris under Arago, and subsequently proceeded to Königsberg, where he became a pupil of the illustrious Bessel. His inaugural dissertation was upon the methods of calculating the orbits of comets, and he obtained the degree of Doctor in 1839. He subsequently visited Berlin where Encke was then one of the great masters of astronomical science of the day. On returning to Geneva he was appointed Professor of Astronomy and Director of the Observatory; these positions he continued to occupy nearly up to the time of his decease. The observations made under his direction were published in various parts, commencing in 1843, and related to astronomy, magnetism, and meteorology. He took part in a number of geodetical operations in Switzerland, and was the representative of Geneva on the Swiss Geodesic Commission.

Plantamour was a man of considerable private means, and hence was independent of the very modest salary attaching to his official position. A few years since he presented a 10-inch refractor to the Observatory of Geneva, and a building suitable for it was erected at his expense. This instrument has already done good work in the hands of Dr. Meyer. Plantamour devoted much attention to cometary astronomy, one of his most elaborate investigations being his determination of definitive elements of Mauvais' comet of 1844, which was observed from July 7 in that year, to the middle of March, 1845, and therefore offered a favourable opportunity for the calculation of the true form of orbit. Plantamour's result was a somewhat notable one: after taking into account the effect of the attraction of the planets during the comet's visibility, he concluded that at the passage through perihelion in October, 1844, the comet was moving in an elliptical orbit with a period of revolution of 102050 ± 3090 years. In 1846 he made extensive calculations bearing upon the motion of the two heads of Biela's comet, the results of which will be found in No. 584 of the *Astronomische Nachrichten*. He further discussed the elements of what was called at the time "Galle's second comet," 1840 II. (*Astron. Nach.*, No. 475-6). In this paper he pointed out some anomalies in the intensity of the comet's light, similar to what has been observed from time to time in other comets.

Plantamour was placed on the list of Associates of the Royal Astronomical Society in 1844; he was a corresponding member of the Academy of Sciences of the Institute of France, and honorary member of the Academy of Turin. Few of those colleagues who were at work at the commencement of his astronomical life now remain.

ON SIR WILLIAM THOMSON'S GRADED GALVANOMETERS

TWENTY years ago the experimental sciences of electricity and magnetism were in great measure mere collections of qualitative results, and, in a less degree, of results quantatively estimated by means of units which were altogether arbitrary. These units, depending as they did on constants of instruments and conditions of experimenting which could never be made fully known to the scientific public, were a source of much perplexity and labour to every investigator, and to a great extent prevented the results which they expressed from bearing fruit to the furtherance of scientific progress. Now happily all this has been changed. The absolute system of units introduced by Gauss and Weber and rendered a practical reality in this country by the labours of the British Association Committee on Electrical Standards has changed experimental electricity and magnetism into sciences of which the very essence is the most delicate and exact measurement, and enables their results to be expressed in units which are altogether independent of the instruments, the surroundings, and the locality of the investigator.

The record of the determinations of units made by members of the Committee, for the most part by methods and instruments which they themselves invented, forms one of the most interesting and instructive books in the literature of electricity, and when the history of electrical discovery is written the story of their work will form one of its most important chapters. But besides placing on a sure foundation the system of absolute units, they conferred a hardly less important benefit on electricians by giving them a convenient nomenclature for electrical quantities. The great utility of the practical units and nomenclature, which the Committee recommended, soon became manifest to every one who had to perform electrical measurements, and has led within the last year to their adoption, with only slight alterations, by nearly all civilised nations. Although it is not yet quite twelve months since the late Congress of Electricians at Paris concluded its sittings, the recommendations which it issued have been widely adopted and appreciated by those engaged in electrical work, and have thus begun to yield excellent fruit by rendering immediately available for comparison and as a basis for further research the results of experimenters in all parts of the world. Soon even the ordinary workmen in charge of dynamo machines or employed in electrical laboratories will be able to tell the number of volts and amperes which a generator can give at a certain speed and under certain conditions, to determine the number of amperes of current required to light an incandescence lamp to its full brilliancy, or to measure the capacity of a secondary cell in coulombs per square centimetre.

But in order that the full benefit of the conclusions of the Paris Congress may be obtained it is essential in the first place that convenient instruments should be used, adapted to give directly, or by an easy reduction from their indications the number of amperes of current flowing in a particular circuit, and the number of volts of difference of potentials between any two points in that circuit. To be generally useful in practice these instruments should be easily portable. and should have a very large range of sensibility; so that, for example, the instrument, which suffices to measure the full potential produced by a large Siemens or Edison machine, may be also available for testing, if need be, the resistances of the various parts of the armature and magnets by the only satisfactory method; namely by comparing by means of a galvanometer of high resistance the difference of potential between the two ends of the unknown resistance with that between the ends of a known resistance joined up in the same electrical circuit. In like manner the ampere measurer should be one that could be introduced without sensible disturbance into a circuit of low resistance to measure either a small fraction of an ampere, or the whole current flowing through a circuit containing a large number of electric lamps. These conditions are fulfilled by two instruments recently invented and patented by Sir William Thomson and called by him Graded Galvanometers. To give a short account of these instruments is the object of the present article.

I. The Potential Galvanometer.

The galvanometer used for measuring differences of potential in electrical circuits is shown in Fig. 1 which is engraved from a photograph of the actual instrument. It consists of two essential parts, a coil and a magnetometer. The coil is made of silk covered copper or German silver wire of No. 32 B.W.G. When made of German silver wire it contains about 2,200 yards of wire wound in 7,000 turns, and has a resistance of over 6,000 ohms. It is made in the form of an anchor ring having an outside diameter of fourteen centimetres and an inside diameter of six centimetres. The diameter of section is thus four centimetres. The coil is wound within a mould of proper shape and dimensions, and is then impregnated with melted paraffin under the receiver of an air-pump. A solid compact ring is thus obtained, which does not require a wooden case; and which served round with a covering of silk ribbon looks well and is not at all liable to get out of order. The coil thus constructed is attached to one end of the horizontal wooden platform P shown in the drawing, and kept firmly in its place by a pair of wooden clamps fitted to the lower half of the coil, and screwed firmly to the end of the platform. When in position the plane of the coil is vertical, and at right angles to a V groove that runs along the middle of the platform. The centre of the coil is opposite to and about one and a half centimetres above the bottom of this groove.

On the platform P rests the magnetometer M (shown in plan in Fig. 2), which consists essentially of a system of magnets properly supported so as to be free to turn round a vertical axis, and shielded from currents of air by being enclosed in a quadrantal shaped box having a closely fitted glass cover. Each magnet is fully one centimetre in length, and is made of glass-hard steel wire of No. 18 B.W.G. Four of these magnets mounted in a frame with their poles turned in similar directions from the "needle" of the instrument. The frame carrying the magnets is made of two thin bars of aluminium placed side by side with their planes vertical and about a centimetre apart; and connected by a bridge of sheet aluminium. The ends of the magnets are fixed in holes in the vertical sides of the aluminium frame so that the four steel needles form a set of four horizontal parallel edges of a rectangular prism.

In the bridge connecting the two sides of the frame a sapphire cap is fixed, and this rests on an iridium-tipped point standing up from the bottom of the containing box. The sides of the frame are made long enough to form when brought together at one end an index about nine centimetres long of the shape shown in Fig. 2. The point of the index ranges round a scale of tangents placed round the curved edge of the bottom of the box. To prevent error from parallax the bottom of the box, with the exception of the narrow strip occupied by the scale, is covered with a mirror of silvered glass. The observer when taking a reading places his eye in such a position that the point of the index just covers its reflected image, and reads off the deflection indicated by the position of the point of the index on the scale of tangents. The scale is engraved on paper, and firmly fixed to the bottom of the box by photograper's glue; and thus any change of length due to varying amount of moisture in the atmosphere is avoided.

The magnetometer box rests on three feet and a flat spring. Two of these feet, which are in a plane perpendicular to the plane of the box and passing through the supporting point and the zero of the scale, slide in the V groove cut along the middle of the platform: the third foot rests on the plane surface on one side of this groove, the spring on the other side. By this arrangement the magnetometer is rendered perfectly steady and can be moved with perfect freedom along, but only along the platform. A small circular level carried by the box shows when the plane of the magnetometer is horizontal. This adjustment is made by means of the two screws which support the platform at the end remote from the coil.

To lift the system of magnets and index off the bearing cap when the instrument is not being used, or when it is being carried from one place to another, a small collar-piece free to move round the supporting point is raised up by a horizontal screw turned by a head outside the magnetometer box. When raised this collar-piece forms a supporting platform for the needles and securely prevents them from moving about and sustaining damage.

To increase the directive force on the needles when required, the semi-circular magnet shown in the drawing is used with the instrument. This magnet is made of the best steel, and is tempered glass-hard. It is magnetised by sending a current through a semi-circular coil containing it. When in position on the instrument it is supported on two flat pieces of brass projecting from the radial sides of the magnetometer box. The magnet terminates at one end in a cross piece of brass having on its under side at one end a small projecting brass knob. This knob fits into a hollow in one of the projecting arms of brass, while the other end of the cross piece rests simply on the plane surface of the arm. The other end of the magnet is brought to a rounded point which rests in a V notch cut round a cylindrical shoulder on a screw spindle (seen on the right-hand side of Fig. 2), which works through a nut fixed to the other projecting arm of the magnetometer box. The magnet thus rests with its magnetic axis as nearly as may be in the horizontal plane through the axis of the needle, and nearly at right angles to the line joining the centre of the needle's axis with the zero of the scale. Its axis may be placed accurately at right angles to this line by turning the screw until the needle points accurately to zero. The magnet thus mounted remains in the same position relatively to the magnetometer.

The coil is so adjusted that its centre is on a level with the magnetic axis of the needle when the magnetometer is in position. The centre of the magnetic axis, the zero of the scale, and the horizontal V groove in the platform are in the vertical plane through the centre of the coil. Hence if the magnetometer guided by its feet in the V groove be moved along the platform it will carry its magnet with it without disturbing its zero adjustment of the needle, and the magnets will in every position of the magnetometer be in the same field of force.

On the boxwood slip in which the V groove is cut is marked a series of positions of the front or circular edge of the magnetometer, for which the corresponding numbers of divisions of deflection for one volt difference of potentials, when the intensity of the magnetic field at the needle is one C.G.S. unit, are the terms of the geometric series . . . 8, 4, 2, 1, $\frac{1}{2}$ . . . These numbers are stamped on the boxwood slip opposite the marks indicating the corresponding positions. The number of divisions of deflection for the nearest position of the magnetometer, that at which the centre of the magnetic axis of the needle is as nearly as may be at the centre of the coil, is not generally a term of this series, but it is determined in every case, and like the others is stamped on the platform.

The instrument is used for the measurement of high potentials with the semicircular magnet in position; but for low potentials the magnet is dispensed with, and the needle left under the earth's directive force alone. The field intensity given by the magnet of each instrument is determined before the instrument is sent out, and is painted on the magnet. The intensity of the field without the magnet, at the place at which the instrument is used has if necessary to be determined. In practice it will generally be found convenient to use some position of the magnetometer which gives a convenient number of divisions of deflection per volt for the field employed. This position is determined by the user of the instrument, who marks it on the platform by drawing two vertical lines on the sides so as to prolong two white lines which are marked on the sides of the magnetometer.

The instrument as thus constructed admits of a very wide range of sensibility. By diminishing the distance of the magnetometer from the coil from the greatest to the least, the sensibility of the instrument can be increased fifty fold: and by removing the field magnet from the instrument and leaving the needle under the influence of the earth's force alone, a sensibility fifty times still greater can be given to it. For the practical purposes for which these instruments are designed the suspension of the needle by cap and point is the most convenient; but with this suspension there is always, with low directive forces, a slight error due to friction: and it is therefore not advisable to push the sensibility of the instrument further by diminishing the directive force of the earth's magnetism. An instrument of this kind, however, made for special purposes with a silk fibre suspension could be rendered more and more sensitive up to the limit of instability by so placing a magnet or magnets as, while not interfering with the uniformity of the field at the needles, to diminish more and more the earth's directive force. This method of increasing the sensibility of a galvanometer although quite commonly used by scientific electricians is not, I have reason to believe, at all well-known generally, and recourse is had, altogether unnecessarily in many cases, to troublesome astatic combinations in order to obtain sensibility.

An important feature of this instrument in connection with its use for the measurement of high potentials is the arrangement of terminals which has been adopted. In certain circumstances when the ends of the coil of a potential galvanometer are attached to terminals fitted with binding screws, it is convenient to connect the instrument with the circuit by wires attached to these screws; but in the case of a dynamo circuit giving between the terminals of the coil a potential difference of eighty or a hundred volts and upwards, this plan of connections has been found highly dangerous. If the wires are twisted together and are ordinary gutta percha covered wires there is always a liability to accidents which may cause conduction from one wire to the other, and the destruction of the wires. Again the ends of the wires are almost sure when removed from the instrument to be left dangling either in contact, or so as to be easily brought into contact inadvertently by a passer by, with the certain result if the dynamo is running, of the immediate fusing of the wires. To prevent the possibility of such an accident Sir William Thomson has used as terminals for the coil two strong strips of copper about 1½ cms broad which stand up vertically facing one another about a centimetre apart, within a vertical cavity in the wooden block behind the coil.

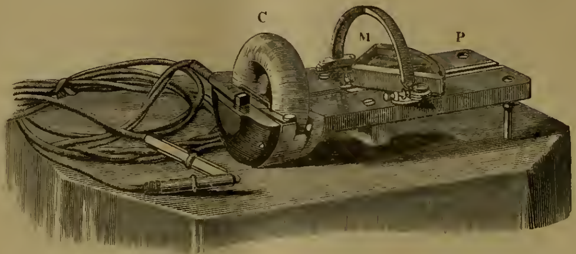


FIG. 1.

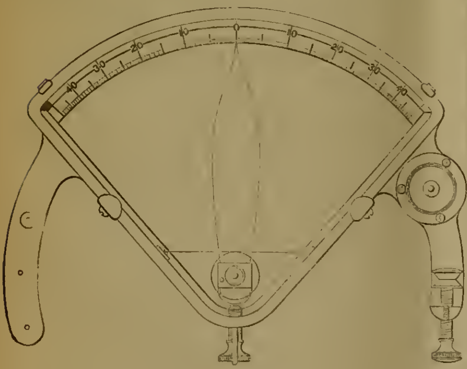


FIG. 2.

To prevent any current from flowing through the coil except when a reading is being taken, the small spring contact key, shown behind the coil in Fig. 1, is inserted between one of these terminals and the coil. The leads for connecting the instrument with the circuit have their ends brought together so as to terminate in two parallel strips of stout copper kept apart by a piece of wood and held in position by a good serving of strong waxed cord. The two copper strips with the piece of wood between them have their ends turned down at right angles to their length, and when connection is to be made are pushed down into the cavity between the two bars to which the ends of the coil are attached. These bars are placed sufficiently near together to be forced a little apart by the contact piece, and thus give a secure spring contact. The leads are made of thin stranded copper wire, well protected by a thick woven covering of cotton, and are very flexible. They terminate in two spring clips (shown in Fig. 1) made each of a strip of stout copper held firmly against the flat side of a piece of wood, of semicircular section, by an india rubber band passed round a groove in a semicircular piece of brass soldered to the copper strip, and round the back of the piece of wood. A groove carried along the piece of wood above the elastic band prevents the copper strips from turning round relatively to the wood, and thus a good and safe contact is made between the copper and anything on which it may be clipped. These clips are quite as efficient as binding screws and a great deal more convenient. They can in an instant be attached to or removed from a wire or lead of any size and in any position. For convenience in the use of the instrument the covering of one lead is coloured red, of the other blue.

II. *The Current Galvanometer.*

This instrument is shown in Fig. 3. It differs from the galvanometer above described only in the coil and arrangement of terminals. The coil is made of stout copper strip about 1·2 cm. broad and 1·5 mm. thick, wound in six turns, insulated by asbestos paper placed between. The outside diameter of the coil is about 10 cm., the inner diameter about 6 cm. It is covered like the other with silk ribbon, and attached in a similar manner to the platform P. A magnetometer exactly the same as that described above is used with the instrument, and all that has been said above with regard to the graduation of the potential galvanometer is applicable also in the present case, except that now amperes, not volts, are the subject of measurement.

This instrument is of course only suitable for the measurement of continuous currents, but owing to the small resistance of the coil, it can be left without risk of damage in a circuit with a current of upwards of 100 amperes flowing continually through it, while it is of sufficient sensibility to measure with accuracy, when the needle is acted on by the directive force of the earth alone, a current of from 1-10th to 1-100th of an ampere.

In special instruments for measuring very strong currents the coil is made of a single turn of massive copper strip, fitted with proper terminals to obviate undue heating at the contacts. With this mode of construction, an instrument can be made which shall measure with accuracy currents of from 1-10th of an ampere to 1000 amperes.

A pair of well-insulated leads several yards long, made of copper-wire cable containing 133 strands of wire of ·32 mm. diameter (No. 30 B.W.G.), and therefore very flexible and of inappreciable resistance, are sent out with each instrument to be used with it. These are shown coiled on the table beside the instrument in Fig. 3.

The terminals of the instrument and the mode of including it, by means of its leads, in any circuit in which it is to be used, are worthy of a little attention. In order that the galvanometer may be used to measure the currents in different circuits, it must be introduced into or withdrawn from each circuit with as little disturbance as possible to the current in that circuit. To do this without the complications of switches or arrangements of binding screws, the very simple plan of terminals, shown in Fig. 3, has been adopted. The ends of the copper strip forming the coil are brought out horizontally behind the instrument, one above the other, with a thin piece of wood between them for insulator. On one end of the leads for attachment to these terminals is a spring clip, formed of two stout strips of copper, one attached to each lead, kept apart for a short distance along their length by a thickish piece of wood, and held in their places by a serving of waxed cord at that place. The ends of the copper strips project beyond the separating piece of wood about two or three inches, and are bent round into similar curves, with their convexities turned towards one another. They have sufficient spring to bring their convex portions into contact, but they are held together at that place by a stout india-rubber band passed round a groove in the edges of the two semicircular pieces soldered on the backs of the strips. The points, however, of the strips are a little distance apart. If, now, the clip just described be pushed over the terminals of the coil, the jaws of the clip will be separated, but before separation takes place each of them has come into contact with a terminal of the coil. Hence if the leads form part of a galvanic circuit, the current, before the galvanometer is attached, passes from one lead to the other across the jaws of the clips, and after these have been separated, through the galvanometer coil; and it is plain that no cessation of the current, and in practical cases only an infinitesimal disturbance can be caused by introducing the galvanometer. Sparks are thus altogether avoided, and the galvanometer is included in the circuit by a single simple and sure operation. When the leads are withdrawn from the coil-terminals the action is simply the reverse, the jaws of the clip have come together at their convexities before the terminals of the coil have lost contact with them.

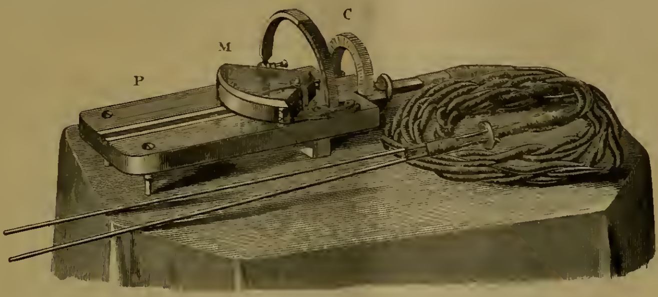


Fig. 3.

In practice two stout wires which have one pair of ends attached to one of these spring clips are included in each circuit, the current in which is to be measured by the galvanometer. The instrument is placed with its leads attached to its terminals in a convenient position, so that the free end of the leads may reach easily the spring clips of all the circuits. The terminals at that end are similar to those of the galvanometer. They can therefore be pushed in between the jaws of each clip to allow the current to be read off, and withdrawn without disturbing the current in the circuit. The leads are shown attached at one end by their spring clip to the galvanometer, and at the other end to a spring clip supposed included by means of the two straight pieces of wire in a galvanic circuit.

This arrangement is exceedingly useful for a great number of purposes, as for example for measuring the currents charging secondary cells, or flowing through the various parts of an electric lighting circuit, or for measuring the whole current sent into the circuit by the dynamo or generator.

ANDREW GRAY

NOTES

THE German Association began its proceedings on Monday at Eisenach, when Prof. Haeckel delivered a lecture on the interpretation of nature by Darwin, Goethe, and Lamarck. The attendance at the meeting amounted to about 1000.

THE autumn meeting of the Iron and Steel Institute was opened on Tuesday at Vienna in the great hall of the Vienna Ingenieur und Architekten Verein. In the absence of the president, Mr. Josiah Smith, the vice-president of the Institute, Mr. I. Lowthian Bell, took the chair. The British and other foreign guests were then welcomed, in the name of the Government, by Baron Possinger, the Governor of the province of Lower Austria, and in the name of the city by the burgomaster. Mr. Bernhard Samuelson, M.P., of Banbury, was chosen president of the Institute for the next two years. The place of next year's Congress it was decided should be London. The Congress next proceeded with the reading of the papers set down for the day. After this work was concluded, the Members were conveyed by steamer down the Danube to inspect the works which have been commenced by the Vienna Corporation for improving the navigation of the river. Thence the guests were taken to Nussdorf, and proceeded to the top of the Kahlenberg, a hill in the vicinity. The first day was wound up by a banquet, at which the guests were entertained by the municipal authorities of Vienna. The present is the fourth meeting which the Institute has held upon the Continent, it having met at Liège in 1873, at Paris in 1878, and at Dusseldorf in 1880. The number of guests from abroad is nearly three hundred. They include not only Members of the English Institute, but visitors from America, Germany, France, Belgium, Spain, and Russia. The business portion of this autumn's Congress is expected to occupy three days, but fully a week will be spent in excursions and other festivities, and in visits to the chief ironworks and mines of Austria and Hungary.

M. BARTHELEMY ST. HILAIRE has completed the translation of Aristotle's "History of Animals," which will be published shortly by Baillière, and will extend to four volumes 8vo, with preface, notes, and commentary. The learned senator delivered last Saturday before the Academy of Moral and Political Science, of which he is a member, a lecture on his translation, showing that in this work, executed after numerous dissections of animals sent to him by Alexander, the great philosopher exhibited a penetration of mind which had been unsurpassed in his other treatises, and had been praised by Buffon and Cuvier. M. Barthelemy St. Hilaire contends that the descriptions were originally accompanied by illustrations, to which numerous allusions are made in the text.

THE inventory of the fortune left by the late M. Giffard has been completed. The whole amounts to about 7 million francs; 2 milions are devoted to legacies, and the other 5 are bequeathed to the French Government to be spent in foundations useful for the promotion of knowledge. No decision will be taken by the Government before the Council of State has given an opinion on the question of accepting the legacy. The same formality will be complied with even for the sum of 50,000 francs which has been bequeathed to the Academy of Science, as well as to the Societé des Amis des Sciences, and Société d'Encouragement. But it has been suggested that the 5 millions should be employed in the foundation of a "Caisse Giffard" for the help of inventors in their discoveries.

THE Dutch Society of Sciences, at Harlem, recently awarded gold medals to Herr Neumayer, of the Hamburg Maritime Observatory, and Herr Buijs-Ballot, of the Utrecht Meteorological Institute, for eminent services in meteorology. The prize-subjects for the current year (to January 1, 1883) are briefly these:—(1) Influence of light on the electric conducting power of selenium; are other electric properties also modified, and other matters similarly influenced by light? (2) Chemical relations of the principal elements of the bile. (3) Chemical relations of terpenes. (4) Influence of structure and elasticity on the compound tone (the timbre) of sonorous bodies. (5) Examination of Clerk-Maxwell's theory of the electric medium, and its relations to the electro-magnetic theory of light. (6) Decomposition of organic matters in bare ground, and ground covered with vegetation. (7) Origin of the mesoderm in vertebrates. (2) Development of one or several species of annelids. (9) Ditto of echinoderms. For the following year (to January 1, 1884):—(1) Nature and composition of the *Terpen* of Friesland and Groningen, their animal and plant remains, &c. (2) Mariners' compasses and the means used to remedy the effects of oscillations and trepidations of the ship, also of the ship's iron. (3) Intensity of the light emitted in different directions from surfaces reflecting light by diffusion, and those emitting proper light; law of dependence of this intensity on the angle of emission and the nature of the luminous surface. (4) Change of refrangibility of light through motion of the luminous source or the refringent medium. (5) Structure of the kidneys of mammalia, specially as regards the epithelial lining in the different subdivisions of the renal tubes. (6) Condensations of different gases on the surface of solid bodies at different temperatures. (7) Study of the (probable) explanation of many physical and chemical phenomena by motions of particles of a system about a state of equilibrium. (8) Peripheric nervous system of various osseous fishes. (9) History of the development of one or several species of Lamellibranchs. (10) The phenomena of electric discharge in rarefied gases. The prize offered, in each case, is (at the author's option) either a gold medal or a sum of 150 florins; a supplementary premium of 150 florins may be given if the memoir be thought to deserve it. Memoirs to be written in Dutch, French, Latin, English, Italian, or German, and sent to the Secretary in the usual way.

A SERIES of researches having been undertaken by several Russian physicians as to colour-blindness, Dr. Kolbe has just published in the newspaper *Vrach* (*The Physician*) the results. Out of 10,828 railway servants examined, no less than 251 were colour-blind, and 32 proved to have an imperfect capacity for distinguishing colours. The average percentage of colour-blind would thus be 2·6; but the five doctors who have made these investigations arrived at very different percentages, namely, from 0·85 to 5 per cent. Three other doctors have made experiments on sailors and pupils in naval schools and have found a much higher percentage—6·08 per cent. of colour-blind, and 8·5 with imperfect vision. Among scholars of naval schools the percentage of colour-blind is however smaller, that is, 1·6 and 1·95. Women are subject to a far smaller extent to colour-blindness. Thus, Dr. Kolbe, who has experimented both on men and women, discovered among the men 2·5 per cent. of colour-blind and 7·5 with imperfect vision, whilst among women he has discovered only 0·16 per cent. of colour-blind and 3 per cent. with imperfect colour vision.

AT King's College, London, a course of lectures on Agriculture will be given during the ensuing winter by Mr. Frederick James Lloyd, F.C.S., of the Royal Agricultural Society of England. The lectures will be given on Thursday evenings at 6 p.m., beginning October 12.

UNDER the title of *Timehri* the Royal Agricultural and Commercial Society of British Guiana have begun the issue of a half-yearly journal edited by Mr. E. F. Im Thurn. The journal, however, is not to be devoted solely to agriculture and commerce, but is intended as a record of all important work bearing on the scientific exploration of the colony. Such a permanent record will be of the greatest utility, and under Mr. Im Thurm's care we may expect some valuable contributions to science. Among the articles in the first number are:—"Tame Animals among the Red Men of America," by the editor; and "Note on a Journey up the Cuyuni," by Mr. J. S. Blake. The term *Timehri*, we may say, is a Carib word, and denotes those curious hieroglyphics found so plentifully on the rocks of British Guiana.

IN the new number of the New Zealand *Journal of Science*, Mr. A. K. Newman advocates the formation of a New Zealand Association of Science similar to the British Association. We are glad to see any effort to promote science in our colonies, though we should have thought that the New Zealand Institute, combined with the *Journal of Science* itself, would render any such Association superfluous. But why not attempt the formation of an Australasian Association?

THE annual Conference of delegates from scientific societies was held at Southampton during the meeting of the British Association. Efforts have been made to enlist the co-operation of local societies all over the kingdom, and obtain their aid in carrying out the work of several of the British Association Committees, but so far, we regret to see, not with much success. Still the Conference is capable of doing good work, and we hope will continue its efforts.

AN International Electrical Exhibition has been opened at Munich.

MESSRS. CASSELL, PETTER, AND GALPIN have issued Part I. vol. ii. of the Encyclopædic Dictionary, extending from Cable to Conarum. It seems to us to be in all respects up to the standard of the first volume, noticed by us some time since.

UNDER the title of "Brehm's Zoological Atlas," Mr. T. R. Johnston of Edinburgh has brought together the leading illustrations to Brehm's well-known "Thierleben." As an aid to the teaching of the subject the Atlas will be found really serviceable, and will be especially interesting to children and useful in leading them to take an interest in science.

WE have received a further supply of University Calendars. That of University College, Liverpool, is pleasant reading in some parts; the list of donations and subscriptions to the young college is quite worthy of Liverpool, and might well excite the envy of more struggling institutions. Here we have 10,000*l.* for a Chair of Natural History, another 10,000*l.* for a Chair of Chemistry, and the like sums or nearly so, for Chairs of Philosophy, of Art, of Mathematics, for a chemical laboratory, and so on, besides thousand on thousand for other purposes. Liverpool College has had a good start, and much will be expected of her. The Calendar of Firth College, Sheffield, is small and business-like, and in the statement of the objects of the college, the governors show that they have a satisfactory idea of what such an institution should be and do. We have also the Calendar of University College, Wales, in whose curriculum science has a place.

TWO interesting cases of explosion are described by Herr Pfaundler in a recent number of Wiedemann's *Annalen*. A closed glass tube two-thirds filled with liquid carbonic acid was inserted a few centimetres deep in a bath of carbonic acid and ether brought to a temperature of – 100° C., in order to get crystallised carbonic acid. Beautiful crystals were soon formed in the immersed part of the tube, and a layer of the liquid acid remained above. The tube was then raised by its upper part into the air, and in a few minutes it exploded violently. This tube had often before borne a rise of temperature to 31°. The explosion is attributed to thermal expansion of the solid carbonic acid (as a more likely cause, than vapour-pressure on glass rendered brittle by a low temperature). In the second case, a large sheet zinc bell-gasometer, used exclusively for keeping oxygen gas, was concerned. It had stood about six months unused, containing a little of the gas. When the issuing gas was being tested with a glowing match, an explosion occurred, shattering the apparatus. Any entrance of hydrogen or coal-gas is out of the question. It is supposed that the water had gradually absorbed acid vapours from the air of the laboratory, and that the zinc had been thus attacked, yielding hydrogen. The zinc was in fact somewhat corroded. It is recommended that the zinc in such cases be coated with a lac.

IN a recent communication to the *Rivista Scientifico-Industriale*, Prof. Palmieri concludes from experiments (1) that glycerine in contact with an ammoniacal nitrate of silver solution partially reduces the metal in the cold state, and with heat the reduction is more pronounced, and gives the appearance of a metallic mirror; (2) that with addition of a solution of caustic potash, either in the cold or hot state, complete reduction is produced, with a most brilliant metallic mirror; (3) that some substances accelerate the reduction, such as alcohol and ether; and (4) that, operating in the cold state and in darkness, the reduction is more brilliant and rapid that when operating in light. On the whole it appears that the reducing action referred to may be applied industrially with advantage to the silvering of mirrors, both on account of the facility of the process and its economy. The exact proportion of the components is important, and Prof. Palmieri promises particulars shortly.

A SIMPLE anemoscope and anemometer, designed by the Brothers Brassart of Rome, at the instance of Prof. Tacchini, especially for use in meteorological stations of small resource, is described in the *Riv. Sci. Ind.* (Nos 12-13). The chief peculiarity in both instruments is the system of free transmission, obviating prejudice to the indications from changes of temperature; the axis has several universal joints in its course, and in the case of the anemoscope passes down freely through a central hole in the plate bearing the compass card, a weight being hung at the end of it. It carries an index just over the card. In the anemometer the weighted axis has a perpetual screw acting on a toothed wheel, which, by means of a system of jointed rods, actuates three discs having peripheral numbers, in such a way as to present a numerical record of the wind's velocity in a given time. About forty of these anemoscopes and anemometers are now at work at various Italian stations.

EXPERIMENTS have been recently made in Rome by Signors Capranica and Colasanti regarding the action of oxygenated water on the system. Physiologically absorbed (according to Hueter's method) the substance acts as a poison, quickly killing animals, the fatal dose varying with the animal's size (about 25 cc., is enough for a dog weighing 3 kgms., 75 cc. for one weighing 13 kgms.). The poisonous action appears in all the great functions of the body, especially that of the spinal cord; the excito-motor power of that organ is over-excited, as shown by convulsive phenomena (tetanus, locomotor ataxy, &c.). The physico-chemical acts of nutrition are also profoundly disturbed, as is proved by the very pronounced glycosuria previous to death. All these disturbances are attributable to decomposition of the H_2O_2 in contact with the tissues. The consecutive phenomena in poison with oxygenated water are identical (the authors say) with those M. Bert has observed as resulting from the action of compressed oxygen.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius* ♀) from South Africa, presented by Mr. H. Banfield; a Moustache Monkey (*Cercopithecus cephus*) from West Africa, presented by Mrs. Heath; two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, presented by Mr. F. J. Newton; a Great Anteater (*Myrmecophaga jubata* ♀) from Parana, presented by Sir William Wiseman, R.N.; a Vulpine Phalanger (*Phalangista vulpina* ♂) from Australia, presented by Mr. W. Marston Clark; three Gold Pheasants (*Thaumalea picta* ♂ ♂ ♀), six Bamboo Partridges (*Bambusicola thoracia*), a Common Moorhen (*Gallinula chloropus*) from China, a Black Kite (*Milvus migrams*), captured in the Red Sea, presented by Mr. Theodore A. W. Hance; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. W. Pilcher; a Squirrel Monkey (*Chrysothrix sciurea* ♂) from Brazil, a Ring-tailed Coati (*Nasua rufa*) from South America, deposited; a tiger (*Felis tigris* ♂) from India, two White-eared Conures (*Conurus leucotis*) from Brazil, two Dusky Parrots (*Pionus violaceus*) from Venezuela, a Horned Parrakeet (*Nymphicus cornutus* ♀) from New Caledonia, received in exchange; a Wapiti Deer (*Cervus canadensis* ♀), a Geoffroy's Dove (*Peristera geoffroii* ♀), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

COMETARY DISCOVERIES.—By telegram to the Earl of Crawford's Observatory at Dunecht, M. Cruls, director of the Observatory at Rio Janeiro, announces the presence of a bright comet in the morning sky, the position of which on September 11·718 M.T. at Rio, was in R.A. 9h. 48m., Decl. – 2° 1′; it was visible to the naked eye.

On Sunday last, Mr. A. Ainslie Common, of Ealing, while observing the sun with a special telescope (reflector with glass reflecting-surfaces only), found a fine comet near the sun: nucleus bright, tail about 4′ long, and apparently much brighter at each side, giving the appearance of two tails. Mr. Common compared it for position with the sun's limbs, and from his observations we find for the comet's place at Greenwich noon, on September 17, R.A. 11h. 33m. 58·3s., Decl. + 1° 42′ 16″; the hourly motion in R.A. appeared to be + 1m. 14s., and in Decl. + 4′·5.

M. Cruls thought his comet might be the expected one of 1812, but this is certainly an oversight. Were the comet of 1812 in his observed right ascension on September 12, its declination would be much further north than that observed if the comet were approaching perihelion, and much further south if it were receding therefrom. Whether the comet detected at Rio is identical with the remarkable one discovered by Mr.

Common, it would be premature to decide upon present data. The Brazilian Telegraph Company has cabled from Madeira two positions for September 12 and 13, obtained on H.M.S. *Triumph* by Capt. Markham, but taken in conjunction with the Rio message, they tend to throw a doubt upon the accuracy of some of the figures so far received.

Another comet discovered by Mr. Barnard is announced in a telegram from Boston, U.S., to Dunecht, it is described as circular, 2′ in diameter, with some central condensation. An observation at Harvard College gives the following position:—

Sept. 14·8162 G.M.T.: R.A. 7h. 19m. 17·8s, Decl. + 16° 3′ 51″.

Daily motion in R.A.: + 1m. 44s.; in Decl.: + 43′.

There is no possibility of identity of this comet with that of 1812.

THE TOTAL SOLAR ECLIPSES OF 1883 AND 1885.—Observers of the total solar eclipse on May 6, 1883, will have but very limited observing-room, and in fact will be confined for stations to one or two of the smaller islands or islets of the Marquesan group, the Roberts Islands of the Admiralty Chart. Wide separation of the parties to secure better chances of favourable weather will therefore be impracticable. The same contingency will occur in the case of the total eclipse next following, viz. that of September 8, 1885, where the course of the central zone is again almost wholly a sea-track. In this case observers will be limited to the southern parts of the north island of New Zealand, and to the extreme northern point of the southern island.

The following figures will indicate the precise conditions:—

Long. E.	Latitude, N. limit of totality.	Latitude, Central Eclipse.	Latitude, S. limit of totality.
°	° ′	° ′	° ′
171	– 39 31·4	– 40 20·2	– 41 10·2
173	39 42·0	40 31·0	41 21·0
175	39 55·0	40 43·8	41 34·4
177	– 40 9·5	– 40 58·8	– 41 49·2

The duration of totality on the central line in longitude 175° will be 1m. 52s.

GEOGRAPHICAL NOTES

AT the Southampton meeting of the British Association Mr. Joseph Thomson read a paper *On the Geographical Evolution of the Tanganyika Basin.* The keynote of this paper is struck by a reference to a recent lecture of Dr. Archibald Geikie. to the Royal Geographical Society, in which he points out that the days are now over in which the scientific geographer is content with the simple description of the superficial aspects of the various regions of the globe. He must also know how they came to be, and what they have been in the past. This line of inquiry is applied by Mr. Thomson to the lake regions of Central Africa, but more particularly to the Tanganyika Basin. In the first place he presented a bird's-eye view of the lake regions from the Indian to the Atlantic Ocean, bringing into relief only the most prominent features of the geography, but describing more in detail the aspect of the Tanganyika Basin, round which the chief interest centres. From a description of these purely superficial matters he proceeded to describe what these have been in the remote past, and the manner in which they have been evolved, being of course compelled to call in the assistance of the sister science geology. The conclusions he arrived at as to the primary origin of the region are, from purely hypothetical considerations, based on the theory of a shrinking nucleus, and the necessary effects on the earth's crust arising therefrom. At a later stage, however, he is on safer grounds when he is able to appeal to the rocks themselves as to the aboriginal conditions of the African continent south of the Equator. These, according to Dr. Thomson, prove the existence of an immense central sea cut off from the ocean by the elevation of the continent, and which was almost coterminous with the present drainage area of the Congo. An elevated ridge was upheaved along the eastern boundary of this sea, the origin of the trough of Tanganyika, by the collapse of the centre of this ridge and the central sea, subsequently drained away to the west, leaving Tanganyika isolated. Mr. Thomson then proceeded to describe how its secondary characters arose, and its scenery was moulded, by the action of sub-aërial denudation on rocks of different powers of resisting the decomposing and eroding agents, and explained the curious marine-like type of its shells, the origin of its outlet, the Lukuga, the freshening of the water of the lake, and finally the curious intermittency of the outflow. The various stages in the evolution of the Tanganyika Basin were summarised as follows:—The first appearance of the future continent, we have been led to believe from various theoretical considerations, was the appearance of a fold of the earth's crust bounded by two lines of weakness converging towards the south, which fold gradually rose till it appeared above the ocean, first along these two lines of weakness, in the form of a series of islands, which finally join, inclosing in their centre a large part of the ocean. This inclosed water area formed a great central sea, and the inclosing land along the lines of weakness is now indicated by the east and west coast ranges. In the second stage the continent of Africa south of 5° N. lat. presented the outline of the continent of to-day. The third stage shows the central plateau with the great central sea very much diminished in size, and almost coinciding with the present Congo Basin. There is as yet no evidence of the existence of Tanganyika. After an enormous period of undisturbed deposition of sand in the sea, the fourth stage is ushered in by a period of great continental covulsions. On the line of the future Tanganyika a huge boss of rock is intruded into the throbbing crust, and the surrounding region elevated to a considerable extent, followed by the subsequent collapse of the body of the elevated area originating the great abyss of Tanganyika. The fifth great stage is marked by the formation of a channel through the western coast mountain, causing the draining of the great central sea, which immediately becomes the inner drainage area of the Congo. The sixth stage then sees Tanganyika isolated as a lake by itself, from which time dates the moulding of its present scenery, the formation of an outlet, the freshening of its waters, and the lowering of its level, and finally we have seen that the intermittency of the lake's outflow is explained by the probable fact that the rainfall and evaporation nearly balance each other in ordinary seasons.

THE Geneva correspondent of the *Times* sends some notes on an interesting paper recently read by Prof. Calladon:—"So far back as 1880 M. de Saussure suggested the probability of the level of Lake Leman being much lower than it had been a few centuries previously, and that there had been a time when the upper part of Geneva formed a peninsula, washed on every side except that of Champel, by the waters of the lake. This theory has lately been comfirmed by the observations of Prof. Calladon, who, at the recent meeting of the Association of Swiss Geographical Societies, read a paper on the subject that attracted much attention. It results from the Professor's investigations that the Plateau of the Tranchée, to the south-east of the city, and the hill once crowned by the temple of Diana, and now by the cathedral, are parts of the same lacustrine terrace, both being composed of regular beds of sand and gravel, having an inclination of 30 to 37 degrees, and dipping in a north-westerly direction. Superimposed on these beds is a horizontal layer of pebbles of an average thickness, much exceeding the thickness of the oblique layers underneath. The height of this layer, Prof. Calladon contends, corresponds with the former *maximum* level of the lake, which was 28 to 30 metres higher than the present level. The excavations for the foundation of the new theatre which were laid in 'drift,' had to be carried to a great depth, and included 3000 square metres of ground. It was quite evident from the nature of the deposits, which had not been previously disturbed, that hereabouts the Arve, once upon a time, joined the Rhone, and other excavations have indicated the old course of the former river to the point at which it now takes its departure. Underneath the inclined bed of pebbles and gravel comes glacial clay, identical in every respect with the glacial clay that now underlays the bed ot the Rhone. It is from the depth of drift resting upon this platform of gravel clay that Prof. Calladon calculates his estimate of the lowering of the level of Lake Leman in modern times. He is confirmed in his conclusion by the fact that the deposits in the ancient bed of the Arve are not alone similar in kind to the deposits still brought down by the river, but identical with them in chemical composition. In the opinion of Prof. Calladon, Geneva, at a period not many centuries before the Christian era, occupied a strategic position analogous to that of many other cities of antiquity in being built upon a promontory almost surrounded by water. The uncovering of the platform of glacial clay enables Prof. Calladon further to ascertain the minimum level of the lake at the time when the superincumbent layers of Alpine sand and gravel were brought down by the Arve. It follows, from the geometric measurements which have been made, that the surface of the bed of glacial clay is only 85 centimetres below the present level of the lake, and 4 metres above its bottom at Geneva. Hence the level of the lake at the time in question must have been at least 3 metres above its present level, for otherwise the Lower Rhone could not have existed. As regards these estimates, it should be remembered that the difference in time between the maximum and minimum levels of the lake has to be reckoned by centuries, and that the volume of rivers and lakes fed by Alpine snows varies with the seasons."

M. Lessar, who made last year an interesting journey to Saraks, has returned from a second journey in the same country, as far as Herat, and publishes an account of it in the *Golos*. All the route, from Askabad to Saraks, 185 miles, goes along the foot of mountains through a completely flat country, which is usually called Attek. This name, however, which signifies "the foot of the mountains," is unknown in Persia and Afghanistan. That part of this oasis, which was occupied by the Tekke-Turcomans, was usually known as Akhal, whilst the south-eastern part of the oasis was known as Arakadj. Only two places of the Attek, Luftabad and Shilghyan, are occupied by Persian Shiites, the remainder are Turcomans, having immigrated from Merv after a bloody struggle with the former inhabitants, at the beginning of this century. The population live mostly in clay-houses, the number of felt tents diminishing very rapidly, and the clay-houses which formerly were built within small earthen fortifications, are now mostly erected outside of them. Water is scarce in the Attek, the streams coming down from mountains being few, and in the hands of Persians, who often take the water for their fields. The population of the Attek, between Askabad and Saraks, is estimated by M. Lessar, at about 7000 Turcoman inhabitants. They carry on agriculture, and have good orchards, as well as good gardens in the neighbourhood of the Persian settlements. But altogether they are very poor.

A telegram, dated Isefjord, September 5, has been received in Stockholm, *viâ* Tromsö, from the Swedish Geological Expedition dispatched to Spitzbergen, according to which snow covered the island as early as August 30, and the members are thus compelled to discontinue their researches, and intended to sail for Beeren Island. The results of their labours were very important. All was well with the Meteorological Expedition at Smith's Observatory.

Another message, similarly conveyed, but dated August 24, has also been received from the Swedish Meteorological Expedition, from which it appears that observations commenced at Smith's Observatory on August 15, with the exception of the magnetical, which were delayed until the 21st, in consequence of the difficulty in firmly fixing the instruments. From August 15 to 21 the mean temperature and the readings of the barometer were respectively as follows:—15th, temp. +3·1° C., bar. 748; 16th, temp. +1·5° C., bar. 749; 17th, temp. +3·9° C., bar. 749; 18th, temp. +3·6° C., bar. 752; 19th, temp. +3·7° C., bar. 754; 20th, temp. +4·5° C., bar. 751; 21st, temp. +3·9° C., bar. 752. At mid-day of the 16th snow fell, while pools became covered with ice; the minimum temperature was +0·1° C. The weather had up to that date been dull with little rain. Wind being generally from west to east, with an average force of 1 (Beaufort's scale). There was little ice at sea, but the fact that four smacks had been frozen in in Storfjord caused the members some anxiety, as they were not quite prepared, as yet, to face the winter. As these four vessels have since got away, this will probably be the last message we shall obtain from the expedition this year.

Owing to the enormous quantities of drift-ice in the Kara Sea the steamer *A. E. Nordenskjöld*, bound for the Jenisei, has put back to Vardö. Capt. Johannesen states that he attempted four times—August 31, September 1, 7, 8—to penetrate Matoschkin Schar, and was compelled to turn back. He went up alongside Waigats Island into the Kara Strait, where he saw ice as far as 54° long., and would have been frozen in here, if the vessel had not possessed such powerful machinery.

Herr Karl Pettersen, of Tromsöe, has given the name of "Arktis" to a great land-mass which he maintains at one time extended between Norway, Novaya Zemlya, and Spitzbergen. His theory is based mainly on the existence of a submarine plateau which recent Norwegian expeditions have found in the region referred to. He also maintains that such a land-mass would account for the present geological and biological conditions of Norway and Spitzbergen, and that it extended to the conclusion of the Quaternary period.

Parts 6 to 10 of the new edition of Balbi's "Allgemeine Erdbeschreibung" have been sent us by Hartleben of Vienna. The recasting of the work by Dr. Chavanne continues to be thoroughly carried out, and the illustrations and maps are very good.

Dr. Otto Finsch, who for the last two and a half years has been travelling in Polynesia and Australia, under the auspices of the Berlin Academy of Sciences, may soon be expected home. A large part of his rich collections in all departments of natural science and ethnography, has already arrived in Berlin, and the rest is on the way. He has visited the Sandwich Islands, the Marshall group, where he stayed a long time, the Carolines and New Britain, New Zealand, Australia, and Tasmania. He stayed for a considerable time among the islands in Torres Straits, as well as on the south coast of New Guinea.

The permanent Commission of the "Association Géodesque Européene," the object of which is to promote the measurement of the earth by General Bayer's system, has been meeting at the Hague under the presidency of the Spanish General Hanez. Representatives of France, Austria, Germany, Italy, Spain, Switzerland, Norway, Roumania, and Holland attended the first meeting, and were welcomed by the Dutch Foreign Minister, Mr. Rochussen. Prof. Oppolzer (Austria), who is the secretary of the deputation, gave the annual report of the Association. Several other members presented communications upon the geodesic work in their respective countries.

An edition for 1882 of the "Handbook of Jamaica," the first issue of which we noticed at length, has been published. Several important alterations and additions have been made. Stanford is the London agent.

The new number of the *Deutsche Geographische Blätter* of the Bremen Geographical Society, contains some long communications from the Brothers Krause, who have been wintering at Chilkoot, in North-west America. They give details concerning journeys which they made during the past winter and spring, in which, among other things, they obtained much information concerning the Chilkoot Indians. The number also contains an interesting lecture by Prof. Karl Möbius, on the influence of food supplies on the spread and migration of animals. Dr. Fr. Hirth has two communications:—On the Walls of the Towns of Kwang-tung, and on the Chinese Coast from the boundary of Annan to Tien-pai, from Chinese sources.

In consequence of the very hot and dry weather experienced in Russia during this summer, the water has become very shallow in all rivers, so that navigation meets with great difficulties on the Volga and Northern Dwina.

We regret to learn from a telegram received at Copenhagen from Vardöe that it is feared the Danish North Polar Expedition under Lieut. Hovgaard is already ice-bound on the coast of Novaya Zemlya. The Kara Sea was closed by ice in the middle of August. It will be remembered that Lieut. Hovgaard intended to make for Cape Chelzuskin, from which he was to make an attempt to force his way northwards.

UNWRITTEN HISTORY, AND HOW TO READ IT[1]

It has now for some years been the custom at the meetings of the British Association for the Advancement of Science, for one of its members to be deputed to deliver a lecture, not to his fellow-members, for whom in the ordinary programme an amply sufficient supply of mental food has been provided, but to the operative classes, in the town where the annual meeting happens to be held. Such a custom has much to commend it, for all alike—the rich and the poor, the worker with the head and the worker with the hand—are interested in the advancement of that science, or "natural knowledge," for the promotion of which this association, like its elder brother the Royal Society, was founded.

An occasion like the present, moreover, gives a good

---

[1] A lecture to the working classes, delivered at the meeting of the British Association for the advancement of science, held at Southampton, *August*, 1882, by John Evans, D.C.L., LL.D., F.R.S., &c. Revised by the Author.

opportunity of treating of some subject which lies within the range of all observers of what is going on in the world around them, which may even be of local interest, or to speculate on which may give an additional zest to an evening stroll or a day's relaxation from toil. It is not, however, easy to find a subject of this kind; and yet, perhaps, if I talk to you this evening of those who, in times more or less remote from the present day, have lived and laboured in this part of the globe, I shall at all events have a theme of some general human interest. And if, in addition to laying some particulars of their method of life before you, I can point out the methods by which our knowledge of the manners and customs of remote antiquity is obtained; if I show you the way in which the successive links in the chain of circumstantial evidence relating to human progress are forged, you will be able to appreciate the value of the application of scientific methods to the study of the past, and to feel that our present knowledge of antiquity rests upon something more secure than vague conjecture. It is fortunate for me that in and around this town of Southampton is what may be termed the home of some of the witnesses I propose to call, so that if I am able to interest you in what they have to reveal, many of you will have the opportunity of examining them and cross-examining them yourselves at your leisure. The subject of my lecture, "Unwritten History, and how to read it,' is, as you may imagine, is one in which testimony of various kinds is admissible; and, as in the case of many of the most important trials, much may depend upon what, at first sight, would appear to be a trivial common matter.

The term which I have used, "Unwritten History," is so comprehensive that it might be made to embrace the whole series of events which have happened in this world from its first creation until the written annals of the historian begin. It might be expanded so as to comprise the whole of the geological record, as exhibited by the testimony of the rocks, and even to go back to a time when it seems probable that the elements composing our globe had not been consolidated, but existed in a gaseous condition. I propose, however, to limit the term this evening, so that it may not extend beyond the period during which the human race has dwelt upon the earth. I need hardly say that, compared with the time which geological facts prove that the world has existed, this period of human occupancy is relatively short, however vast it may appear when we come to compare it with the few centuries embraced in our ordinary chronology. But of this it will be time to speak when we have traced back our evidence as far as our present knowledge will enable us to go.

With regard to that evidence, or the means by which we must attempt to read unwritten history, one of the principal aids that can be called in is the written history of the past. The ancient writings of Greek and Roman authors carry us back some three thousand years; while the annals of Egypt and Assyria, and those preserved in the pages of our Bibles, make us to some extent acquainted with the habits and customs of still earlier times. And in the same way the accounts of recent travellers who have been brought in contact with races of men unacquainted with even the most simple appliances of modern civilisation, serve to throw a light on what must have been the condition of most of the occupants of other parts of the world before those appliances were known. But, after all, our best evidence is to be derived from the relics of the past which, from time to time, we find buried in the earth, and from the circumstances under which they are discovered. Such relics are often of much service even in illustrating that portion of past time which falls within the limits of written history, especially so far as relates to the habits and customs of everyday life, as to which, except incidentally, our chroniclers are usually silent. The "princes and kings" who "flourish or may fade," "the unsuccessful and successful wars" whose records make up the bulk of our histories no doubt possess an interest of their own; but all that relates to the infancy and childhood of the human family and the development of its mental and material resources has for many minds a far greater charm, and much that concerns it is only to be gathered from a study of unwritten history.

But before going back to any really prehistoric times, it will be well to consider briefly a few points in connection with the written history of the town in which we are assembled. It was not always called Southampton, but was in Saxon times known as Hamtune, and under that name appears upon coins struck at the local mint from the middle of the tenth until the middle of the twelfth century. In the same manner Northampton was at one time only known as Hamtune, and it was to distinguish these two towns that the one received the prefix of North- and the other of Southampton.

Curiously enough, the name of Hamtune, which appears to be compounded of two well known Saxon words—Ham, our English home, a farm or possession; and Tune, the modern town—is more probably, both at Northampton and at Southampton, connected with the old British name of the river which flows past the town. The Nene of Northamptonshire seems to be called the Antona or Anton by the Roman historian Tacitus; and the Test of "Suthamtescire," as the country of this town is called by the Venerable Bede, still retains in part of its course this same name of Anton. The old geographer Ptolemy calls Southampton Water the mouths of the river Tris-anton, or possibly the three mouths of the Anton; and the Roman town which stood near this place was known by the name of Clausentum, which Camden interprets as a Latinised form of the British Claudh-Anton, the port of Anton.

I shall not attempt to determine the claims of Bittern, or Old Hamtune, to represent the Roman town; but the fact that Roman remains still exist here may be cited as a proof that whatever may have been the encroachments of the sea since Roman times, they have not destroyed all traces of the Roman settlement on this site, nor can the relative positions of the sea and the land have materially altered within the last 1800 years. It will be well to remember this when we hereafter come to consider the antiquity of some of the earlier traces of the presence of man in this part of the world. When, once, in ascending the stream of time, we have passed the date of the Roman occupation of this country, we enter upon the domain of unwritten history, or at all events find ourselves within its border provinces.

Who were the people whom the Romans found here on their arrival, and what was their civilisation? Historians give us some information on this point, which is, however, to be supplemented from other sources. Cæsar, whose invasions of Britain date some ninety years earlier than the actual Roman conquest, tells us that the southern part of this island was occupied by Belgic tribes who had come over from the Continent, who for the most part retained their original names, and were often subject to the same chiefs as their brethren on the mainland. Those who occupied this part of Britain appear to have been the Belgæ, whose name at least has on the other side of the Channel survived in that of Belgium. The habits and customs of these southern Britons were the same as those of the Gauls. They were acquainted with iron, gold, silver, copper, tin, and bronze, and had, moreover, a coinage of their own. Our knowledge of this coinage is not, however, derived from any ancient historians, but from a study of the coins themselves. By a careful record of the spots where coins of the Ancient Britons have been found we have been able to show that particular forms belong to particular districts, and, in the case of some of the coins which bear inscriptions, to determine the names of British princes, and to fix the districts in which they reigned. Here in Hants, and in the neighbouring county of Sussex, we find coins struck by two Princes, Tincommius and Verica, as to whom written history is silent, but who appear from their coins to have been the sons of Commius, who probably is the Commius mentioned by Cæsar.

It has been supposed, from a passage in Cæsar's "Commentaries," that the Britons in his time were unacquainted with the use of coined money; but this passage may have been misread. At all events, the coins themselves prove that the supposition is erroneous, and, moreover, that long before Cæsar's time a native coinage existed in Britain. You may ask how this can be proved by coins which bear neither dates nor inscriptions. I will attempt to answer this question, and to show you in what manner this chapter of unwritten history has been read. Coins such as we now know them, struck of a certain weight and with some established device upon them, were unknown even among the most civilised nations of antiquity until about seven hundred years before Christ; and it was not until about three hundred and fifty years before Christ that any extensive coinage of gold was issued at any one place. About that time some mines were discovered in Macedonia which produced about £250,000 worth of gold annually. Most of this was converted into coins rather heavier than our sovereigns, by Philip II. of Macedon, the father of Alexander the Great. These coins bore on the one side a head with a laurel-wreath upon it, and on the other a Victory, in a two-horse chariot. The coins were so well known, and gold from other sources was comparatively so scarce, that the use of these pieces, which were known as *Philippi*, spread through the whole of Greece and her colonies along the shores of the Mediterranean. Whether as the result of raids upon Greek towns, or from more peaceful contact with Greek colonies in what is now the south of France, the Gauls became acquainted with them, recognised their usefulness, and proceeded to strike coins in imitation of them. As was to be expected, the art of these imitations was far inferior to that of the original coins. Each copy in its turn served as a model from which other copies were made, and as is often the case, the copies were in many instances larger than the originals; so that by the time the art of coining had reached the northern part of Gaul the size of the coin had much increased, and the devices upon it had degenerated into a widespread bust with a laurel-wreath, and with the hair arranged in rows of locks of even size behind, and in crescent-shaped curls in front, while additions had been made to the original head in the shape of a kind of band around it and an ornamental covering for the neck. Such coins have been found in considerable numbers in England, principally in our southern counties, and especially in Kent. Of their origin from the Macedonian *Philippus* there can be no doubt; but how are we to judge of their date, and of the length of time that coins were known in Britain before Cæsar's landing? It is in this manner:—There are some British princes whose names are recorded by Roman historians and by Roman inscriptions, and to whom therefore we can assign a fairly certain date; and of some of these princes coins are known. They have on them devices such as at first sight appear almost unintelligible, but which by a succession of intermediate forms occurring on coins without inscriptions upon them, can be traced back to the head with the laurel-wreath, while on the reverse side there is always a horse of more or less barbarous form. We have, therefore, evidence of an uninterrupted succession of coins copied the one from the other, beginning with the coins with the widespread head and ending with the inscribed coins. Now each of these successive copies must have been intended to pass current with the coins from which they were copied, and if they had all been of one weight and of one quality of gold it might have been possible for the whole series to have been struck within no very lengthened terms of years. But, as it happens, there is a great diversity in the weight and fineness of the coins, those with the widespread head being of fine gold, and often weighing nearly 120 grains, and the last of the series being of much baser metal and only weighing about 84 grains. In the process of successive copying only the most striking parts of the device, and those most easy to imitate, such as the wreath and locks of hair, survived, and the face, being more difficult to copy, was the first to disappear. Coins with merely a mis-shapen lump upon them in lieu of the face usually weigh about 96 grains, and the farther they get from the original the lighter the coins become. Now the original weight of the *Philippus* was 133 grains; and assuming that it was first imitated in B.C. 300, and that the weight had become reduced to 84 grains in B.C. 20, and also that the diminution in weight always went on at the same rate, we find by calculation that the date at which the weight would have become reduced to 120 grains—that of the earliest British coins—is B.C. 226. Probably, however, there was a less tendency to reduce the weight and quality at the beginning than towards the end of the series, but the coins justify us in saying that the inhabitants of southern Britain were sufficiently civilised to make use of a coinage about 150 years before Christ, or 100 years before the time of our first Roman visitor, Julius Cæsar, if not indeed at an earlier period.

Besides these gold, silver, and brass or copper coins, with devices upon them derived from Gaulish copies of a Macedonian original, there are other coins cast in tin, with devices in imitation of some coins of Marseilles, in the South of France, which also tell us the same story of a close intercourse with Gaul. Many of these were cast in wooden moulds, as is proved by the grain of the wood being visible in relief upon them. Such coins have been found with iron tools and weapons in the ancient encampment of Mount Caburn, near Lewes; but iron or steel must have been in use for some four or five centuries in this country before the time of Cæsar's invasion.

In graves which must belong to the first few centuries before Christ, we find swords of iron with ornamental bronze sheaths; and there are highly decorated shields with artistic scroll patterns upon them, and sometimes with ornaments of red enamel, which belong to the same period. The warriors of those times had horses and chariots, the latter with iron tires and linch-pins to the wheels, and the harness of the former provided with bronze and enamelled buckles. Of this Early Iron Age, however, we learn more from the remains of ancient dwellings and cemeteries on the Continent. In one of these cemeteries at Hallstatt, in the Austrian Tyrol, upwards of a thousand graves have been examined; and as it was the custom to bury with the dead a number of objects of an ornamental or useful kind—possibly with the view that they might be of service in a future state of existence—we are able to reconstitute the surrounding conditions of their life. Great care was bestowed upon their weapons, some of the swords having hilts of ivory inlaid with amber, both probably derived from foreign commerce; some daggers had golden sheaths; their helmets were of bronze, as were also their girdles, bracelets, and brooches, which present an infinity of different forms. Their pottery was of graceful shape, and some of it highly ornamented. Many of their vessels were made of bronze, sometimes artistically ornamented, with figures of animals—as, for instance, a milk-cup, the handle of which is in the form of a cow with a calf behind her.

But mixed with these graves containing iron weapons are others in which swords, spear-heads, and hatchets of bronze have been found; and it is a remarkable circumstance that the iron weapons appear to have been imitated from those of bronze. cannot go into the details of the matter, but I may observe that the forms, though readily cast in bronze, are exceedingly difficult to forge in iron; and the only inference that can be drawn from this fact is this, that the bronze weapons and tools must have been in use at the time when iron was introduced as a substitute for the softer metal.

But if iron or steel thus superseded bronze, there must have been a time when bronze was the only metal in use for weapons and tools, and to this period antiquaries have given the name of the Bronze Age. Such terms as Iron Age, Bronze Age, or Stone Age mean, however, only certain stages of civilisation, and not only chronological periods applicable to the whole of the world; for while the inhabitants of one country had acquired a knowledge of iron and had given up bronze for such weapons as swords, in other countries bronze may still have been in use, and in others again it may have been entirely unknown. Here in the South of Britain iron, as already remarked, is thought to have been in use some four or five centuries B.C., and before that time we have evidence of the prevalence of a Bronze Age in Britain probably for a period of not less than ten centuries. We can read this chapter in our history partly by the contents of ancient grave-mounds or barrows, and partly by means of the bronze objects found dispersed in the soil. Bronze, or, as we now generally call it, gun-metal, is a mixture of copper and tin, and the proportions which produce the toughest and most useful alloy are about nine of copper to one of tin. No doubt in some part of the world, probably Asia, native copper, such as is found in so many countries, was first in use; but at present the traces of this copper-using age are on this side of the Atlantic but faint. On the other side, in some parts of the United States, numerous instruments of pure copper have been found. These have been hammered out cold from native copper, and not cast. Where and when it was discovered that the admixture of a small proportion of the softer metal, tin, made copper harder and more fusible, is at present a mystery; but it is remarkable that the same discovery seems to have been made in the New World as in the Old, for some of the weapons and tools of Peru, made before there was any contact with Europeans, are manufactured from bronze of the ordinary composition. Here in Britain, our Bronze Period is well illustrated by relics, representations of some of which are shown upon the wall. The swords, spear-heads, daggers, and shields speak for themselves, and exhibit marvellous skill in the art of casting and hammering out. The various tools may also be recognised, and many, such as the chisels and gouges, do not differ materially from those of the present day. The hatchets or axes are either flat blades, sometimes with wings or flanges at the sides, or are cast with a socket to receive a crooked haft. In this country they are never provided with an eye for the helve like our modern axes. The way in which the socketed form was developed from the flat blade is susceptible of being traced, and we can learn from the hatchets themselves that the art of producing them with a socket was a foreign invention, and not originally discovered in this country. Let me dwell on this for a minute. The flat blade, which was cast in a single open mould and hammered into shape, was no doubt the earliest form. It, moreover, closely resembles some of the earlier hatchets made of another material, to which I shall presently have to call your attention. But these flat blades, it was found, could be rendered stronger by being hammered at the sides so as to form flanges upon them, much like those on modern rails. The blades were next cast with these flanges upon them, and it was then found advantageous to make them expand in the middle of the blade, so as to allow them to embrace the two sides of the split haft in which they were mounted. Eventually these projecting wings were hammered over so as to produce a kind of semicircular pocket for the haft on each side of the blade. At this stage a brilliant idea occurred to some ancient founder, and by means of a clay core he produced a single socket in the body of the blade itself, and thus did away with the labour of hammering out the wings on the flat blade and turning them over, and also with the trouble involved in making a deep notch in the haft, so that it might run down each side of the blade. But these semicircular wings had become a recognised feature in this class of hatchets, and out of regard to this fashion the earliest of the socketed blades were cast with the two wings on each face, in imitation of those of the older form. As has so often been the case in such developments, what was at one time of essential service survives at another as a useless ornament. And now comes in this little bit of history which these hatchets enable us to read. It is evident that the first socketed blades must have been cast in a country where the prevailing type of hatchet had the semicircular wings on each face; but this kind of hatchet, though abundant in some parts of the Continent, is very rare in Britain, and we are therefore justified in concluding that the art of casting hatchets with a socket was introduced into this country from abroad. Not but what our native founders cast plenty of hatchets of this socketed pattern when once they were acquainted with it, for the moulds for producing them have been found with lumps of metal and various bronze objects in different parts of the Kingdom.

Not only were the bronze-using people skilful as founders, but they understood how to work ornaments in amber and jet as well as in gold, and some few specimens of their ornamental inlaying are such as would do credit to any modern workman. The wooden handle of a bronze dagger found in the grave of a warrior in Wiltshire was inlaid with thousands of minute gold pins, arranged in regular patterns, and the amber pommel of a dagger found in Devonshire was as delicately inlaid with gold as any tortoise-shell patch-box of the last century.

The history of man in the bronze-using stage is, however, better read on the Continent than here. On the shores of many of the lakes of Switzerland, Italy, and the South of France the remains of settlements belonging to the Bronze Age have been discovered. As a safeguard against enemies and wild beasts, it was a custom in those times to construct artificial islands, or platforms carried on piles above the water, on which to erect their dwellings. The same custom also prevailed within the historic period both in Europe and Asia, and something of the same kind was practised in Ireland until comparatively recent times. A similar custom has been observed in other parts of the world by modern travellers. In such buildings, from time to time, disastrous fires occurred, and what was thus lost to the original occupants has been preserved beneath the waters for the instruction of long subsequent ages. Their houses seem to have been formed of interlaced boughs smeared over with mud, after the manner we now term "wattle and daub." They understood the art of spinning and weaving both woollen and linen cloth. Of domesticated animals they possessed the dog, ox, sheep, goat, pig, and finally the horse. In this country they hunted the red deer, the roe, the wild boar, the hare, and some other animals. But they also were to some extent agriculturists, and reaped their corn with bronze sickles. They made vessels of various shapes in burnt clay, but were unacquainted with the potter's wheel, though some cups of amber and a soft kind of jet were apparently turned in a lathe. Though using so many and such well-made tools and weapons of bronze, a certain number of appliances for both peaceful and warlike purposes were made of stone. The skins which they prepared as leather were scraped by means of flint scrapers. Their arrow points were made of flint, and their battle-axes and war maces were in this country carefully wrought out of stone. From the number and varieties of the bronze instruments found in Britain, it has been inferred that their use must have extended over several centuries, and it seems probable that the beginning of our Bronze Period dates back to at least some 1,200 or 1,400 years B.C. Such a date also seems to agree fairly well with what we learn from history as to the trading visits of the Phœnicians to this country in search of tin.

(*To be continued.*)

RECENT PROGRESS IN TELEPHONY[1]

THE Telephone was first introduced to the British public at the meetings of the British Association. In 1876, at Glasgow, Sir William Thomson startled his hearers by announcing that he had heard, in Philadelphia, Shakespeare quoted though an electric wire, by the aid of the invention of Mr. Graham Bell, which he then pronounced to be "the greatest by far of all the marvels of the electric telegraph." In 1877, at Plymouth, I had the pleasure of showing in actual operation the finally developed instrument now known as the Bell Telephone, which I had just brought over from America; and conversation was actually maintained between Plymouth and Exeter. Five years have elapsed since then, and it is fitting that the British Association should hear of the progress of this astonishing apparatus.

In 1877, it was a scientific toy; it has now grown to be a practical instrument. 1,550,000*l.* capital is already embarked in its extension in England, and it is earning a revenue of 109,000*l.* Hitherto it has been practically a monopoly in the hands of a private company, who hold the controlling patents, and of the Post Office, who possess the controlling power, but this monopoly has been broken, and we are about to witness severe competition. It is often said that competition in any business will have the effect of reducing the rates charged to the public, but the experience of the past in railways and telegraphs scarcely teaches this lesson. Undue competition tends to lower the rates for a time, but it eventually leads to amalgamation—to the absorption of the weak by the strong—to swollen and watered capital, and, finally in many instances to higher rates to a too-confiding public. Competition, however, induces better service, and ultimately, in this respect, the public gain.

The free traffic in patents, however, leads to jobbery and speculation of the worst type. We have recently seen a mania for electric speculations that almost rivals the South Sea Bubble period. The public have wildly rushed into ill-matured schemes that have swollen the purses of gambling promoters, have turned the heads of inventors, have retarded the true progress of the beneficial application of this new science to the wants of man, and have thrown away millions upon imperfect schemes. Much has been said against the monopoly of the Post Office in telegraphic business, but at any rate it has the merit that it has checked the rapacity of company promoters and patent-mongers in that branch of the practical application of electricity, while no one can assert that it has checked the progress of telegraphy. During the first week that the telegraphs in this country were transferred to the State, the total number of messages transmitted was 26,000, while in the week ending August 11th it amounted to 724,000. There is no inventor who can assert that his scheme has not received proper consideration, nor show a real improvement that has not been adopted and remunerated; while the improvements of the Post Office itself are freely adopted by other countries, and America itself—the home of the inventor—has found the advanced system of England worthy of acceptance.

Receivers.—The original telephone receiver of Bell has scarcely been improved upon; it remains in form and construction very nearly the same as that which I exhibited in 1877. The perfection of its working depends upon the truth and perfection of its manufacture. It is now more solid and substantial than it was at first, more powerful magnets are used; but still it is the same simple, marvellous, and beautiful instrument that I brought over from America. Mr. Gower has increased its loudness by varying the form of its various parts, and using very powerful horse-shoe magnets of peculiar form; but experience shows that loudness is always obtained at the expense of clearness of articulation; and, although for many purposes the Gower-Bell instrument, which is adopted by the Post Office and is now in use to connect together all the sections of the British Association scattered through the town of Southampton, is more practical, nothing for delicate articulation surpasses the original Bell.

The Paris Exhibition of last year, so fruitful in electrical novelties, did not bring forth any marked improvement in telephonic apparatus. It was noticeable chiefly for its practical applications of the telephone, and particularly to the transmission of singing and music to a distance. M. Ader's modification of Bell's receiver is that almost universally used in Paris. It is a

---

[1] Paper read at the Southampton meeting of the British Association. Revised by the author.

very handy, pretty, and convenient form. He utilises a principle which he calls "surrexcitation." A thick ring of soft iron is inserted between the ear-piece and the diaphragm, and this is said to increase the attractive power of the little horse-shoe magnet upon the vibrating iron diaphragm. A simple experimental apparatus of M. Ader's shows that there is some foundaton for this fact: when a thin steel spring is adjusted close to the poles of a magnet without being attracted by them, the near approach of a mass of iron to the spring will cause it to be attracted by the magnet.

D'Arsonval has also modified the Bell receiver. He has placed the coil in a powerful magnetic field of annular form, and has thereby concentrated the lines of force upon the induced coil. He brings the whole coil within the influence of the field. The effects are said to be magnified, and the increased loudness is not accompanied by the usual loss of articulation. Speech is reproduced without any change of *timbre.*

Telephone receivers of the Bell type are all based upon the magnetic effects of currents of electricity flowing around magnets or bars of soft iron.

The rapid and rhythmic magnetisation and demagnetisation of a bar of iron or the increment and decrement of the magnetism of a magnet, will produce molecular disturbances, in its own mass and in the matter about it, that lead to the oscillatory motions of the whole which produce sonorous vibrations that can be made manifest by various devices, and particularly by that patented by Graham Bell.

Other principles of electricity have also been utilised for telephonic receivers.

For instance, Mr. Edison used the electro-chemical effect. The decomposition of a chemical solution in paper or on chalk by the passage of currents through it, produces a modification of the friction of two moving surfaces, which can reproduce sonorous vibrations, and the result is a very loud-sounding apparatus. I myself had the pleasure, in 1880, of submitting to the Royal Society a receiver based on the electro-thermal effects of the current. The passage of a current through wires always heats them and therefore produces expansion. If the wire be made fine enough, the heat is generated and dissipated so rapidly, the expansion and contraction are so quick, that sonorous vibrations are the result. Although I was able to speak through it very clearly, I have not as yet developed this instrument into a practical form. Professor Dolbear has recently utilised the electro-static effects of currents. His receiver is even more simple than that of Bell. Two flat circular discs of metal are rigidly fixed very close to each other in an insulated case of ebonite. When one disc is electrified positively by a charge of electricity, the other is electrified negatively by induction. These two opposite states produce attractions varying in force with the strength of the signals sent, and the result is that, when telephonic currents are transmitted, we obtain sonorous vibrations, and, consequently, the reproduction of speech.

Many other forms of telephone receivers have been devised and exhibited, in fact I have recently seen quite a crop of them; but as they involve no new principle, and introduce no particular improvement, having been brought out chiefly to try to avoid existing patents, I pass them over, and proceed to the next branch of my subject.

Our present Patent Law is, unfortunately, in so disorganised and chaotic a condition, that evasion is often possible, and hence the questionable morality of doing a thing in another way, in order to avoid the incidence of a royalty, is practically encouraged. The possession of a patent is now no guarantee of property: it is granted without any discrimination, and cannot be upheld without tedious litigation and wasteful expenditure before a non-technical and scientifically incompetent tribunal. We therefore cannot hope for any virtue in English inventors or security for real improvements until our law is thoroughly revised. The question is before the House of Commons, and, when wordy agitators have fully exhausted the patience of our legislators, we may hope for some attention to so real and pressing a want.

Transmitters.—The great novelty and peculiarity of Bell's telephone was that the receiver and transmitter were similar and reversible. Sonorous vibrations of air impinging on an iron disc caused it to vibrate in front of a magnet around one pole of which a portion of an electric circuit was wound. These vibrations of a magnetic substance in a magnetic field produced currents of electricity in the coil of wire on the magnet, varying in strength and direction with the sonorous vibrations, which, proceeding along a wire to a distant station, there varied the magnetic strength of a similar magnet so as to vary its attractive force on a similar disc, by which it reproduced the motions of the first disc, and thus, reproducing the sonorous vibrations of the air, repeated speech. The currents, however, were very feeble; much energy was lost *en route*, and the effect scarcely attained a practical standard. Mr. Edison showed how to strengthen these currents. Taking advantage of a peculiar property of carbon which was supposed to vary in electrical resistance with the amount of pressure brought to bear upon it, he caused the vibrating disc which was spoken against to press upon a button of carbon, and so to vary the strength of a current of electricity passing through it. This varying current, passing through the primary wire of an induction coil, set up in the secondary coil more powerful currents than the Bell instrument produced, and caused louder and more marked effects at the receiving station. Professor Hughes went a step further. He found a combination of materials that were directly affected by sonorous vibrations, which he called a "microphone," and he proved that the effect of the carbon transmitter of Edison was not due to any influence of varying pressure on the mass of the carbon, but was a phenomenon of loose contact. He found a new fact in nature, and he startled the scientific world by introducing an instrument which did for minute sounds what the microscope had already done for minute objects. By the light thrown on the theory of the instrument by Hughes, Edison's carbon transmitter has been so improved by Blake, Hunnings, Moseley, Anders, and others, that little apparently remains to be done. The telephone as a speaking instrument is now well nigh perfect. It is quite possible to swear to a friend's voice at 100 miles distance. The difficulty of making the telephone a practical instrument under all circumstances is not due to any defects in the instrument itself, but to disturbing influences external to it, and consequent on its surroundings. The very pefection and sensitiveness of the apparatus itself are its chief enemies.

The true action of the microphone, or carbon-transmitter, is very little understood: it introduces into a closed electric circuit, through which a current is flowing, a resistance which, varying exactly with the sonorous vibrations impinging upon it, causes the current to undulate in a way exactly analogous to the varying sound waves. This effect is generally assumed to be due to a greater or less intimacy of electrical contact between two semi-conducting surfaces abutting upon each other; but there is now little doubt that it is due to effects of heat generated by the passage of electricity between two points in imperfect contact, whose relative distance is variable. Carbon is the best material for the purpose—first, because it is inoxidisable and infusible; secondly, because it is a poor conductor; and, thirdly, because it has the remarkable property of having its resistance lowered when it is heated—the reverse of metals. This observation is due to Mr. Shelford Bidwell.

The resistance of microphones is very variable: some give 10^{ω}, while others give 25^{ω}, and some even 125^{ω}. The best transmitters that I have worked with (Moseley's) give an average of 20^{ω}.

Attempts have been made to apply mathematical analysis to the determination of the best form and arrangement of microphones, but at present the microphone defies mathematics.

Theory would lead to the conclusion that a carbon-transmitter should have the lowest possible resistance, but practice does not confirm that idea.

Theory again asserts that the resistance of the secondary coil of the induction coil should be equal to that of the line it works, but practice proves the very reverse. On a line giving nearly $1,800^{\omega}$ resistance, the best effects were produced with a secondary wire of only 30^{ω} resistance. The fact is, that the conditions due to heat in the microphone, and to self-induction in the induction coil, are very complicated, and are not yet sufficiently understood to bring the phenomena they affect within the region of mathematical analysis.

Accessories.—I do not intend to speak here of the bells, calls, switches, etc., used in carrying out telephonic operations: there has been nothing that is particularly novel introduced, or that was not previously used in telegraphy. In fact, the whole operations carried on in connection with the so-called "exchange" working are simply telegraphic, and are still in a somewhat tentative condition.

Long-distance Speaking.—I have said that the difficulty in speaking is chiefly due to the environment of the wires employed. Were we to erect a wire from Land's End to John o' Groats, upon lofty separate poles and away from all other wires, there would be no difficulty whatever in speaking between those two places. Conversation has been held in America over 410 miles; in Persia it has been effected between Tabreez and Tiflis, 390 miles apart; in India, over a distance of nearly 500 miles; in Australia, of 300 miles; but in all these cases it was done either at night or under exceptional circumstances, and in all cases the wires were over-ground. Had they been underground or submarine, the case would have been very different. Conversations have been held between Dover and Calais, between Dartmouth and Guernsey, and between Holyhead and Dublin, but I know of no case where any persons have spoken through more than 100 miles of submerged cable. The reason of this diminution of speaking distance is due to the electrostatic capacity of the telegraph line, which absorbs the minute quantity of electricity that makes up the currents employed for telephonic purposes.

In every submarine cable, before a signal can be made at the receiving end, the whole cable must be charged up with electricity, and if there be not sufficient electricity sent in to effect this purpose, practically no signal appears at the distant end. With telephone currents on long cables the whole of the electricity is, as it were, swallowed up—that is, none appears at the distant end, or, if it does appear, it is rolled up in one continuous wave, bereft of those rapid variations that reproduce sonorous vibrations. The newspapers said that the sound of the bombardment of Alexandria was heard at Malta; but, in the first place, the experiment was not tried, and, even if it had been tried, it could not have succeeded. The use of underground wires very seriously impedes telephonic extensions, and with our present apparatus and present knowledge we cannot readily speak over greater distances than 20 miles.

Disturbances.—But there are other disturbing influences at work of more serious import.

When two or more telephone wires run side by side, what is said on one can be overheard on all the others; and when a telephone wire extends alongside telegraph wires, every current on the telegraph circuit is repeated in the telephone, leading to a hissing, frying, bubbling sound that is not only very irritating, but which on busy lines entirely drowns speech. When music is transmitted on one wire, it can be heard equally well on all wires running parallel and contiguous. This is due to induction and to leakage.

(A.) *Induction.*—Induction is a term employed to designate the peculiar influence which electrified and magnetised bodies exert upon conducting and magnetic masses in their neighbourhood. If two wires run side by side for some distance, every current of electricity sent upon one wire will produce two currents in the contiguous wire, the one at the commencement and the other at the end of the primary current of electricity. The greater the intensity, and the more sudden and abrupt the commencement and the ending of the inducing current, the greater effect it has on the induced wire. Those instruments, consequently, which reverse their currents the most rapidly and suddenly, produce the greatest disturbance. The powerful alternative and intermittent currents used for certain electric light systems are death to telephones: they cause an incessant roar that renders speech an impossibility. There are some apparatus in telegraphy that require very powerful currents to work them, which are equally detrimental. Many attempts have been made to cure this evil.

1. The sensitiveness of the receiver has been reduced to lessen the influence of the disturbing currents, and the strength of the telephonic transmitting currents has been increased so as to overpower the induced currents.

2. The influence of one wire on the other has been screened off by inserting metal coverings in connection with the earth between them.

3. The suddenness of the rise and fall of the inducing currents has been modified by the insertion of condensers or electromagnets.

4. Counterbalancing or neutralising effects have been set up by counter-induction apparatus.

But all these plans, and many others, have been proved either only partially successful or wholly abortive; the only effective mode of curing the evil at present practically used is to employ a complete metallic circuit so contrived that the two wires are in very close proximity to each other, or that they twist round each other, so as to maintain a mean average equality of distance between themselves and the disturbing wires. When we have the two wires of a circuit kept at the same mean distance from the disturbing causes, however near they may be, the influence on each must be identically the same, and as the one is used for going and the other for returning, the similar influences must be opposite in direction, and they must therefore neutralise each other. This plan, which was originally devised for underground wires by Mr. Brooks, of Philadelphia, was found to be absolutely true in practice, and the Post Office, having laid down many hundred of miles on this system with perfect success, invariably constructs its circuits both underground or overground in this way. It is, of course, more expensive than a single wire, but the great gain—the absolute freedom from overhearing, the privacy and the absence of crackling—is well worth the extra cost. Wires in submarine cables are invariably laid up with a twist, so that no special contrivance is needed on such wires, and in underground wires not laid up together as cables, they are as a rule, so close to each other that twisting is unnecessary; but for overground purposes twisting is essential, and special arrangements have to be carried out. Professor Hughes showed how this was to be done, and Messrs. Moseley carried it out practically in the neighbourhood of Manchester. The plan adopted by the Post Office for *two* and for *four* wires is shown by the diagram. It is simply and easily carried out; and entails no practical difficulty whatever.

In the neighbourhood of Manchester there are over 400 miles of overground double wire twisted on this plan, working efficiently and thoroughly. I have spoken to a friend 76 miles off, through wires that were erected on poles carring busily-occupied telegraphic currents, without disturbance or difficulty.

(B.) *Leakage.*—The double-wire system is only absolutely effective so long as the insulation is good. The moment insulation fails, connection with the earth is made, and then we have disturbing causes due to currents flowing through the ground, which are increased in proportion to the deterioration of the insulation. Hence, good insulation is essential to telephone working.

The discovery of the telephone has made us acquainted with another phenomenon. It has enabled us to establish beyond doubt the fact that currents of electricty actually traverse the earth's crust. The theory that the earth acts as a great reservoir for electricity may be placed in the physicist's waste-paper basket, with phlogiston, the materiality of light, and other hypotheses. Telephones have been fixed upon a wire passing from the ground floor to the top floor of a large building, the gas pipes being used as a return, and the Morse signals sent from a telegraph office 250 yards away have been distinctly read; in fact, if the gas and water systems be used, it is impossible to exclude telegraphic signals from the telephone circuit. There are several cases on record of telephone circuits miles away from any telegraph wires, but in a line with the earth terminals, picking up telegraphic signals. When an electric light system uses the earth, it is stoppage to all telephonic communication in its neighbourhood. The whole telephonic communication of Manchester was one day broken down from this cause, and in the City of London the effect was at one time so strong as not only to destroy telephonic communication, but to ring the bells. A telephone circuit using the earth for return acts as a shunt to the earth, picking up the currents that are passing, in proportion to the relative resistances of the earth and the wire. The earth offers resistance, and consequently obeys the law of Ohm; hence it is not only essential for a telephonic system that the earth should not be used on any electric light system, but it is also desirable that the earth should be eschewed for telephonic purposes. Thus, the double-wire system adopted by the Post Office and by the Société Génerale des Telephones of Paris, not only cures the ill effects of induction, but it materially diminishes the disturbing influences of earth conduction. The four-wire system of the Post Office effectually checks leakage from one wire to the other—cross contact, as we call it in England—for each wire of the same current is always on a different supporting arm.

A telephone circuit when in connection with the earth gives distinct evidence of every visible flash of lightning, however far off the thunderstorm may be. No difference in time has been observed between seeing the flash and hearing the crash.

It is said that, if a telephone be connected between the gas and water systems of a house, distinct evidence of every flash can be heard. There have been several cases of persons being knocked down while experimenting during a thunderstorm, but no personal injury has been sustained, although the apparatus itself is frequently damaged. In England, at present, we have not found the damage done sufficient to justify the employment of lightning protectors. The use of double wires diminishes the danger to a minimum. On the Continent and in America, however, telephones are invariably protected by lightning arresters where one wire only is used.

There are certain natural currents flowing through the crust of the earth. They are called "earth" currents, and at times acquire such considerable energy, that, with a telephone pressed to each ear, I have been told, although I have not experienced it, that the noise made is as though "your brains were boiling." This is due to the intermittent currents produced by the polarisation of the earth plates.

M. Van Rysslberghe has recently spoken between Paris and Brussels upon a wire nearly 200 miles long, which was used at the same time for ordinary telegraphy, but the experiment was made early in the morning (4 a.m.), and was effected by retarding the telegraphic currents, so as to modify the suddenness of their rise and fall, by means of condensers and electro-magnets. I am unable to understand the advantage of any gain in speaking on a wire which is detrimental to telegraphic communication. Speed is of more importance than speech, and we can telegraph much faster than we can speak. In England speed is everything and we eliminate every influence that retards speed—condensers and electro-magnets in telegraphy circuits are out of the question. M. Van Rysselberghe has endeavoured to extend the idea to cure the effects of induction by destroying the main cause of the disturbance—that is, by reducing the sudden rise and fall of the prime telegraphic currents; but to do this means to retard telegraphy, and we cannot afford in England to cripple the one system in order to benefit the other.

I have recently tried an extremely interesting experiment between this place (Southampton) and the Isle of Wight, namely *to communicate across seas and channels without the aid of wires at all.* Large metal plates were immersed in the sea at opposite ends of the Solent, namely, at Portsmouth and Ryde, six miles apart, and at Hurst Castle and Sconce Point, one mile apart. The Portsmouth and Hurst Castle plates were connected by a wire passing through Southampton, and the Ryde and Sconce Point plates by a wire passing through Newport; the circuit was completed by the sea, and signals were passed easily so as to read by the Morse system, but speech was not practical.

The telephone is very rapidly gaining ground, and, as improvements are effected in its accessories, in its installation, and in its mode of working, its use will still further extend. In Germany it is used very extensively for telegraphic business, there being 1,280 stations worked entirely by telephones, but in England it is not possible in the numerous open and public shops employed as Post Offices to secure that privacy which the telephone requires nor have we yet got over our early prejudices, resulting from the errors made through the inability of the instrument in its earlier form to repeat the sibilant sounds. The instruments of the present day (thanks to the improved transmitters), however, transmit "s's" perfectly.

WILLIAM HENRY PREECE

SCIENTIFIC SERIALS

Journal of the Franklin Institute, September.—On a newly discovered absolute limit to economical expansion in the steam-engine and in other heat-motors, by R. H. Thurston.—Observations with the platinum-water pyrometer, with heat-carriers of platinum and of iron encased with platinum, by J. C. Noadley.—The microscope in engineering work, by R. Grimshaw.—Tests of double raw hide belts, by J. E. Hilleary.—Greatest ringing bells, by J. W. Nystrom.—Report on European sewage-systems, with special reference to the needs of the City of Philadelphia, by R. Hering.—Emerson's power scales, or dynamometer, by J. H. Lord.—Mechanical modifications of the Bessemer plant necessary to adapt it to the economical working of the basic process, by W. M. Henderson.—Prevention of fires in theatres (continued), by C. J. Hexamer.

Bulletin de l'Academie Royale des Sciences de Belgique, No. 7.—On the seat of thunderstorms and their origin, by W. Spring.—On the compound ethers of hyposulphurous acid, and on some organic bisulphides, by W. Spring and E. Legros.—On the brominated derivatives of camphor, by M. Swarts.—Note concerning the priority of the discovery of a relation existing between dilatability and fusibility, by P. De Heen.

Journal de Physique, July.—On the condition of achromatism in the phenomena of interference, by A. Cornu.—On the same, by A. Hurion.—On the actinic transparence of some media, and in particular on the actinic transparence of Foucault mirrors and their application in photography, by J. de Chardonnet.—On methods for determination of the ohm, by G. Lippmann.—Apparatus for regulating the flow of a gas at any pressure, by J. Ville.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti. Fasc. xii.-xiii.—New method for determining the relative internal conductivity of metals for heat, by G. Poloni.—On the theory of systems of electrified conductors, by E. Beltrami.—On the pseudofocus of the paraboloid and on the magnetic centre, by G. Jung.—Contribution to the experimental study of hypnotism in hysterics, by A. Tanburini and G. Seppilli.

Fasc. xvi.—New microtelephonic system, by C. Fornioni.—The crystalline group of Albigna and Disgrazia; stratigraphical and chemico-lithological studies, by E. Bonardi.—On syphilitic reinfection, by A. Scarenzio.—Luni-solar influence on earthquakes, by A. Serpieri.—Contribution to the general physiology of smooth muscles, by E. Sertoli.—The plague of Milan in 1576 and Cardinal Borromeo, by A. Corradi.

Atti della l'Accademia dei Lincei; Transunti. Fasc. xiv.—On the circulation of blood in the human brain, by S. Mosso.—On the microscopical fauna of the Zanclean limestone of Palo, by S. Terrigi.—Internal equilibrium of metallic piles according to the laws of elastic deformations, by S. Allievi.—On the graduation of galvanometers, by Signor Canestrelli.—On the influence of hygroscopic condensation on glass in determination of the density of aqueous vapour, by Signors Macaluso and Grimaldi.—The action of oxygenated water on the system, by Signors Capranico and Colasanti.—On two isomeric acids, santonosic and isantonosic, by Signor Cannizzaro.—On some products of transformation of glutaric or normal pyrotartaric acid, by Signor Bernheimer.—Action of nascent hydrogen on pyrrol, by Signors Ciamician and Dennstedt.—On some derivatives of hexahydronaphthaline, by Signor Agrestini.—On two volumes of autograph drawings of the two brothers Cherubino and Giovanni Alberti, by Signor Cannizaro.—New Carthagenic inscription to Fanith and Baal-Hammon.—Ephemerides and hydrometric statistics of the River Tiber during 1881, by Signor Betocchi.—On the anatomy of leaves (continued), by Signor Briosi.—On the first phenomena of development of *salpa*, by Signor Todaro.—Statistics of the popular banks existing in Italy in the end of 1880, by Signor Bodio.—First outlines of a statistic of the conditions of life of operatives, by the same.—The diminution of illiterates in Italy, by the some.—On the Comet Wells, by Signor Respighi.—On the total eclipse of May 7, 1882, by the same.

SOCIETIES AND ACADEMIES

SYDNEY

Linnean Society of New South Wales, June 28.—Dr. James C. Cox, president, in the chair.—The following papers were read:—Half century of plants new to South Queensland, by the Rev. B. Scortechini. This paper was to some extent a continuation of a previous paper by the same author, and contained the results of further researches on the flora of that part of the country. Among the plants enumerated were many hitherto regarded as strictly tropical, while others had not previously been observed in such warm latitudes.—Contribution to a knowledge of the fishes of New Guinea, by the Hon. William Macleay, F.L.S., &c. This paper gives a list of 120 species of Percoid Fishes collected by Mr. Andrew Goldie at Port Moresby and Cuppa-Cuppa, in New Guinea. They are, with few exceptions, species which have been described by Dr. Bleeker as being found on the northern shores of that island and throughout the Netherlands India Archipelago generally. The new species described are *Serranus Goldiei*, *Serranus magnificus*, *Genyoroge bidens*, *Mesoprion rubens*, *M. parvidens*, *M. Goldiei*, *Diagramma Papuense*, *Lethrinus aurolineatus*. The remainder of Mr. Goldie's collection is to form the subject of a future paper.—A monograph of the Australian Aphroditacean annelids, by Mr. W. A. Haswell.—Two papers were read by Mr. E. P. Ramsay, F.L.S., Curator of the Australian Museum, one containing a description of a new species of *Phlogœnas* (*P. Salamonis*) and of a new species of *Dicrurus* (proposed to be called *D. longirostris*) from the Solomon Islands; the other containing a description of a new species of *Coris* from Lord Howes' Island.—Prof. W. J. Stephens exhibited a few specimens of a lost *Euca-*

lyptus which had been lately re-discovered by his brother, Mr. T. Stephens, in the immediate neighbourhood of Hobart. He stated that the plant (*Eucalyptus cordata*) had only once been seen by botanists since the expedition of d'Entrecasteaux, and then only in two isolated and remote spots.

PARIS

Academy of Sciences, September 4.—M. Blanchard in the chair.—The following papers were read :—Solution, in finite and simple terms, of the problem of longitudinal shock, by any body, of an elastic bar fixed at the unstruck extremity, by M. de Saint Venant.—On the figure of comets, by M. Faye. In this whole question, apparently so complicated, there is merely (he says), the play of solar attraction tending to decompose bodies of very small mass and large volume, and that of solar repulsion (due to incandescence) which begins to act on the evaporable part of those materials, when, freed from all pressure and subject to increasing heat, they commence to form nebulosities of excessive rarity.—On *trombes* observed on the sea at Etretat, by M. Lalanne. The phenomena described, comprising *eleven* trombes, occurred in September, 1851. M. Faye explains them on his theory.—On the distribution of heat in the dark regions of solar spectra, by M. Desains. He gives here his observations with prisms of crown-glass and flint (the previous were with rock-salt). The spectrum is prolonged much further on the side of the rays of great wave-length, than with rock-salt. M. Desains describes an apparatus, for determining, conveniently and surely, the angular distance of any line of the luminous spectrum from one of the cold bands of the dark spectrum.—M. Alph. Milne-Edwards announced that the *Travailleur* had returned from its cruise in the Bay of Biscay, to the west of Spain and Morocco, to Madeira and the Canaries.—Typhoid fever in Paris ; period of 1875 to 1882, by M. de Pietra-Santa. In the first half of this year the deaths from typhoid fever in Paris were 4·60 per cent. of the total deaths (in 1865–7 they were only 1·90 per cent., in 1875, 2·30 per cent.). The fever has most victims in April and in November. Its distribution is unequal in the several arrondissements. There is no direct and constant relation between the number of deaths from it, and the number of the population in the arrondissement, the surface, the density of population, and the general mortality. Medical statistics, with clinical observation, prove the impossibility of referring typhoid fever to a single cause, the fecal origin assigned by the English school.—Theoretical and practical consideration on the phenomena of electro-magnetic induction ; application to the more common types of machines, by M. de Tromelin.—Action of helenine on the bacillus of tuberculosis, by M. de Korab. Helenine seems adverse to the development of the organism.—On the syphilitic bacterium ; syphilitic development in the pig, by MM. Martineau and Hamonie.—On the problem of Kepler, by M. de Gasparis.—Oscillation-balance employed for calculation of moments of inertia, by M. Brassinne.—Researches on the absorption-spectrum of the terrestrial atmosphere, by M. Egoroff. These were carried out at the Paris Observatory with M. Thollon, the electric and other light being sent from Mont Valerien, Montsouris, &c. Details of the spectra are given.—Experimental study of the reflection of actinic rays ; influence of specular polish, by M. de Chardonnet. Every surface reflects in variable proportions each of the spectral radiations. The reflecting power of a liquid is independent of the substances it holds in solution or suspension. Specular polish increases the total quantity of radiations reflected, while the relative intensity of different regions of the spectrum depends on the matter employed.—On the law of cooling, by M. Rivière. He observed the cooling of a platinum wire heated by an electric current in dry air, within a glass cylinder, on which flowed a current of cold water. The wire's temperature was deduced from the variations of its conductivity, and the quantity of heat lost (equal to that developed by the current), calculated by Joule's law. The results are compared with those got from the formulæ of Dulong and Petit and of Rossetti. (The formula of the former is shown, as by other physicists, to give too rapid increase.)—On the law of thermal constants of substitution, by M. Tommasi.—On some combinations belonging to the group of creatinines, by M. Duvillier.—Researches on the circulatory apparatus of regular sea-urchins, by M. Kœhler.—On the innervation of the mantle of some lamellibranch molluscs, by M. Vialleton.—On the intestinal parasites of the oyster, by M. Certes.

September 11.—M. Blanchard in the chair.—Reference was made to the death of M. Liouville, Member, and M. Plantamour, Correspondent. (Funeral discourses on the former, by MM. Faye and Laboulaye, are printed in *Comptes Rendus*).—On the mean temperature of the northern and southern hemispheres of the earth, by Mr. Hennessy. There is reason to believe that the idea of a superiority of temperature of the northern hemisphere over that of the southern must be given up. Mr. Henel considers the southern hemisphere, with its greater mass of water, to have (if anything) the higher temperature, or about 15° 4 C. Herr Hann considers that 15°·2 C. represents the temperature of both hemispheres. Mr. Hennessey views with satisfaction the removal of a difficulty in his theory of climates put forth many years ago.—On the extension of the phylloxera at Béziers in vineyards not submitted to treatment, by M. Henneguy.—Means of combating the disease of the vine, by M. Maistre. He has had good results from applications of greasy water (from washing of sheep's wool) every fifteen days, besides sulphocarbonate of potassium.—Conditions for two linear differential equations without second member to have *p* common solutions ; equations giving the solutions, by M. Lemonnier.—Natural definition of differential parameters of functions, and especially of that of the second order Δ_2, by M. Boussinesq.—Observations of the solar spectrum, by Mr. Langley. This relates to the results of the Mount Whitney expedition. *Inter alia*, it is estimated, that, our atmosphere apart. the solar rays would raise about 3 deg. C. 1 gr. of water in one minute, for each square centimetre of the earth's surface exposed normally to them. Of the total energy which vivifies the world, only a quarter occurs in the visible spectrum and the ultra-violet ; the other three quarters exist in the great infra-red region, whose extension has been so erroneously conceived. The general telluric absorption, at least in dry climates, diminishes to the extreme infra-red. In general, in both atmospheres (the earth's and the sun's), the absorption increases (except in interruptions noted) as the wave-length diminishes. The absolute colour of the photosphere is blue. The maximum energy in the visible spectrum is in the orange.—On the various causes of etiolation of plants, by M. Mer. He inquires into these by a comparison of the phenomena of aquatic plants with those of aërial plants grown in the dark or in moist air.—On a new amputation of an upper limb, by M. Després. For disease of the omoplate this bone was removed, with the arm and part of the clavicle.—Signor Govi presented a small work giving six unpublished letters of Galileo ; also a memoir describing experiments in transformation of electricity of tension into voltaic currents. The latter were made in ignorance of the previous experiments of M. Bichat. With a small Holtz machine Signor Govi decomposed water, getting in three minutes 1 cc. of explosive mixture ; with the same current he vibrated a Froment siren, produced magnetic spectra, obtained very bright sparks by interruption with a steel file, lit an arc between carbons, and actuated a Rhumkorff coil.

CONTENTS

THURSDAY, SEPTEMBER 28, 1882

MODERN PHYSICS

The Concepts and Theories of Modern Physics. By J. B. Stallo. (London: Kegan Paul, Trench, and Co., 1882.)

THIS is, in many respects, a curious work. It shows very extensive reading, as well as much patient thought, on the part of its author; and is, throughout, eminently "readable," although somewhat disfigured by the use of strange and uncommon words, such as "questionability," "irrecusable," "luminar," "consiliences," &c., and even of words apparently made for the occasion. With engaging frankness, the author tells us in the Preface that a previous work of his was written when he

> "was under the spell of Hegel's ontological reveries:—at a time when I was barely of age and still seriously affected with the metaphysical malady which seems to be one of the unavoidable disorders of intellectual infancy. The labour expended in writing it was not, perhaps, wholly wasted, and there are things in it of which I am not ashamed, even at this day; but I sincerely regret its publication, which is in some degree atoned for, I hope, by the contents of the present volume."

His recovery from this direful malady has been unusually complete; but the *sequelae* are still of a somewhat distressing character, for the work is "designed as a contribution, not to physics, nor, certainly, to metaphysics, but to the theory of cognition."

Having been himself at one time enchanted in the Circean sty of metaphysics, the author now sees the evil thing everywhere rampant, and specially in scientific writings. With a subtlety which is occasionally almost admirable, he seems to endeavour, under cover of perfect candour and confidence along with intense zeal for the interests of science, to insinuate into the reader's mind doubts of the validity of some of the most fundamental of scientific hypotheses and reasonings. We rise from a perusal of his volume with a feeling of dawning doubt, which happily vanishes the moment we attempt to find a justification for it. We can, however, fancy some ardent student, unversed in laboratory work and with no great knowledge of physical principles, falling an easy victim to the doubts here suggested; the author all the while smiling grimly to himself as did the spirit of negation when his admiring victim exclaimed—

> . . . . mir wird so dumm
> Als geh' mir ein Mühlrad im Kopf herum.

This insidious weakening of the student's faith in principles and methods is perhaps even more dangerous to scientific progress than what the author in his Preface speaks of as

> "the shallow and sciolistic materialism—I allude, of course, not to its supposed ethical but to its purely intellectual aspects—which for a time threatened to blight the soil and poison the atmosphere even of the old highlands of thought on the continent of Europe, [and which] claims to be a presentation of conclusions from the facts and principles established in the several departments of physical science."

The author is seen at his best and also at his worst in the Chapters on the "Kinetic Theory of Gases;" and the whole character and tendencies of his work will be easily gathered by any one who carefully peruses the following extracts from that chapter. To these we need scarcely add a word of comment:—

> "It thus appears that the pre-supposition of absolute elasticity in the solids, whose aggregate is said to constitute a gas, is a flagrant violation of the first condition of the validity of an hypothesis—the condition which requires a reduction of the number of unrelated elements in the fact to be explained, and therefore forbids a mere reproduction of this fact in the form of an assumption, *à fortiori* a substitution of several arbitrary assumptions for one fact. Manifestly the explanation offered by the kinetic hypothesis, in so far as its second assumption lands us in the very phenomenon from which it starts, the phenomenon of resilience, is (like the explanation of impenetrability, or of the combination of elements in definite proportions by the atomic theory) simply the illustration of *idem per idem*, and the very reverse of a scientific procedure. It is a mere *versatio in loco*—movement without progress. It is utterly vain; or rather, inasmuch as it complicates the phenomenon which it professes to explicate, it is worse than vain:—a complete inversion of the order of intelligence, a resolution of identity into difference, a dispersion of the One into the Many, an unravelling of the Simple into the Complex, an interpretation of the Known in terms of the Unknown, an elucidation of the Evident by the Mysterious, a reduction of an ostensible and real fact to a baseless and shadowy phantom." . . .
>
> "It were work of supererogation to review in detail the logical and mathematical methods by which it is attempted, from an hypothesis resting on such foundations, to deduce formulæ corresponding to the facts of experience. I may be permitted to say, however, that the methods of deduction are only less extraordinary than the premisses. To account for the laws of Boyle and Charles, resort is had to the calculus of probabilities, or, as Maxwell terms it, the method of statistics. It is alleged that, although the individual molecules move with unequal velocities, either because the velocities were originally unequal, or because they have become unequal in consequence of the encounters between them, nevertheless, there will be an average of all the velocities belonging to the molecules of a system (*i.e.* of a gaseous body) which Maxwell calls the 'velocity of mean square.' The pressure, on this supposition, is proportional to a product of the square of this average velocity into the number of the molecules multiplied by the mass of each molecule. The product of the number of molecules into the mass of each molecule is then replaced by the density—in other words, the whole molecular assumption is, for the nonce, abandoned—and the velocity is eliminated as representing the temperature; it follows, of course, that the pressure is proportional to the density."
>
> "Similar procedures lead to the law of Charles and the 'law' of Avogadro (according to which the number of molecules in any two equal volumes of gases of whatever kind is the same at the same temperatures and pressures—a law which is itself a mere hypothesis). It is claimed, on statistical grounds again, that not only the average velocity of a number of molecules in a given gaseous body is the same, but that 'if two sets of molecules, whose mass is different, are in motion in the same vessel, they will, by their encounters, exchange energy with each other till the average kinetic energy of *a single molecule of either set* is the same.'"
>
> "'This,' says Maxwell, 'follows from the same investigation which determines the law of distribution of velocities in a single set of molecules.' All this being granted, the law of Charles and the law of Avogadro (called by Maxwell the law of Gay-Lussac) are readily derived. And at the end of these devious courses of deduction Maxwell adds a disquisition on the properties of the molecules, in which he claims to have made it evident that the mole-

cules of the same substance are 'unalterable by the processes which go on in the present state of things, and every individual of the same species is of exactly the same magnitude as though they had all been cast in the same mould, like bullets, and not merely selected and grouped according to their size, like small shot,' and that, therefore, as he expresses it in another place, they are not the products of any sort of evolution, but, in the language of Sir John Herschel, 'have the essential character of manufactured articles.'"

"Now, on what logical, mathematical, or other grounds is the statistical method applied to the velocities of the molecules in preference to their weights and volumes? What reason is given, or can be given, why the masses of the molecules should not be subjected to the process of averaging as well as their motions? None whatever. And, in the absence of such reason, the deductions of the kinetic theory, besides being founded on rickety premisses, are delusive paralogisms."

"Upon these considerations I do not hesitate to declare that the kinetic hypothesis has none of the characteristics of a legitimate physical theory. Its premisses are as inadmissible as the reasoning upon them is inconclusive. It postulates what it professes to explain; it is a solution in terms more mysterious than the problem—a solution of an equation by imaginary roots of unknown quantities. It is a pretended explanation, of which it were unmerited praise to say that it leaves the facts where it found them, and is obnoxious to the old Horatian stricture: '*nil agit exemplum, litem quod lite resolvit.*'" . . . .

"It may seem strange that so many of the leaders of scientific research, who have been trained in the severe schools of exact thought and rigorous analysis, should have wasted their efforts upon a theory so manifestly repugnant to all scientific sobriety—an hypothesis in which the very thing to be explained is but a small part of its explanatory assumptions. But even the intellects of men of science are haunted by pre-scientific survivals, not the least of which is the inveterate fancy that the mystery by which a fact is surrounded may be got rid of by minimising the fact and banishing it to the regions of the extra-sensible. The delusion, that the elasticity of a solid atom is in less need of explanation than that of a bulky gaseous body, is closely related to the conceit that the chasm between the world of matter and that of mind may be narrowed, if not bridged, by a rarefaction of matter, or by its resolution into forces. The scientific literature of the day teems with theories in the nature of attempts to convert facts into ideas by a process of dwindling or subtilisation. All such attempts are nugatory; the intangible specter (*sic*) proves more troublesome in the end than the tangible presence. Faith in spooks (with due respect be it said for Maxwell's thermo-dynamical 'demons' and for the population of the 'Unseen Universe') is unwisdom in physics no less than in pneumatology."

"*Pure Being* is simply the specter (*sic*) of the copula between an extinct subject and a departed predicate." It is a pity that a man who can so smartly show up the absolute nonsense of the professed metaphysicians (past and present alike) should weaken the force of his really valuable remarks by attacking in a similar style some of the best-ascertained truths of mathematical and of physical science. We repeat that the volume is lively reading, that its smartness is visible in every page, but that its author (having once been bitten by metaphysics) has, in his desire to save others, run a-muck not merely through gossamer webs but also against stone walls. No doubt he has done good:—some of the supposed stone walls he has encountered have proved to be mere stage "properties." But the reader cannot fail to doubt the validity of a method which upsets with equal ease the most irrefragable truth and the most arrant nonsense.

P. G. T.

OUR BOOK SHELF

Amazulu; the Zulus, their Past History, Manners, Customs, and Language, with Observations on the Country, and its Productions, Climate, &c.; the Zulu War, and Zululand since the War. By the Rev. T. B. Jenkinson. (London: W. H. Allen and Co., 1882.)

The Rev. Thomas B. Jenkinson, having been a missionary in Natal between the years 1873-79, proposes to give us his experiences of the country and its people in a work bearing the above ambitious title. But so little information is to be gleaned from its pages on these subjects that the judicious reader will do well to begin and end with the short appendix, which contains a few remarks on the present political situation of Zululand. This appendix consists of extracts from two letters not written by Mr. Jenkinson, and nearly the whole of the book is found to be made up in the same way of quotations from diaries and private letters written by the missionary or members of his family to friends in England, or else of stale passages from the *Cape Argus*, Livingstone's journals, *Macmillan's Magazine*, or the diaries of other missionaries, who flourished half a century ago. Thus the section devoted to "Historical Notices of the Zulu Nation" consists largely of extracts from the journal of the Rev. Francis Owen, originally published in the Missionary Register for 1838! Deducting these wholesale appropriations, the actual amount of text attributable to the compiler will occupy a very small portion of the work. This, however, may be regarded as fortunate, for the quantity is not compensated by the quality of the composition, which is written in a crude, jerky style, and made up mainly of trivial incidents of missionary life. The contributions to science and history are remarkable, as, for instance, the statement that "the British exchanged Java for St. Helena with the Dutch!" (54); that the Zulus are somehow connected with Israel, although they seem to be descended from Ham, "still a common name among them" (33); that the Zulu language "resembles" the Hebrew (18); that in Natal there is a curious animal "called a rock-coney rabbit, a rhinoceros in miniature!" (8); and that Mr. Jenkinson "killed ten of those large rock-pigeons with one shot" (188).

A. H. K.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Lighthouses

In Dr. Siemens's inaugural address to the British Association, reported in Nature, vol. xxvi. p. 398, reference is made to the system originally suggested by Sir William Thomson some years ago, "of distinguishing one light from another by flashes following at varied intervals."

Now in Sir William's article "On the Lighthouses of the Future," in *Good Words*, March 1873, it is shown that the proposal to distinguish lighthouses from each other by diverse groups of occultations had been made by Charles Babbage at least so early as 1851; while, more recently, Capt. Colomb had adopted intervals of unequal length for a code of signals corresponding to the Morse Telegraph Alphabet. This, however, was, as I understand, for ships' night signals, and not for lighthouse purposes.

Further it seems only just to add that, so early as March 27, 1871, Mr. Robert Louis Stevenson described to the Royal Scottish Society of Arts forms of intermittent lighthouse apparatus for exhibiting groups of flashes of occultations of unequal period; these arrangements, possessing the advantage over Babbage's original proposal, that during dark intervals the light is not simply stopped by a screen and thus lost, but sent usefully in other directions to strengthen the bright intervals or flashes.

WILLIAM SWAN

Ardchapel, Dumbartonshire, September 21

The August Meteors

As noted in NATURE, vol. xxvi. p. 378, I observed a bright display of meteors on the night of August 6, at Aberfeldy. On the 7th the sky was overcast with dense clouds all night; but on the following night I saw a more brilliant shower of meteors than on the 6th, with this difference that the meteors of the night of the 8th were mostly of several seconds' duration, and generally left a long, bright train of light behind; also, in place of being on the north of the Milky Way, as on the 6th, they were chiefly on the south of it. A very large and bright meteor burst out about half way to the zenith, and moved nearly horizontally from the south-east towards the west, leaving a long shining streak behind, and lasting close on fifty seconds. I watched the meteors for the next three nights from the parish manse of Logie-Almond, and witnessed on each night (9, 10, and 11) a gorgeous shower. On the evening of the 10th, before the twilight was quite gone, I noticed thirteen very large meteors during the space of a few minutes, although my view of the heavens was very much intercepted by trees and by the manse. Between 11 and 12 o'clock a meteor considerably larger and brighter than Venus under the most favourable circumstances, sailed over the southern heavens, leaving a long train of light which lasted fully a minute. Its position, time, and appearance, were nearly the same as those of the large meteor I saw at Aberfeldy on the night of the 8th. I have not for years, during any month, witnessed such a gorgeous display of meteors as I have seen on the nights specified in August last. But I have scarcely seen any since, except a few bright ones on Sunday night, September 17, at High Blantyre. The display of the August meteors was of a very short duration on each night, and after 12 o'clock not one scarcely could be seen.

Govanhill, Glasgow, September 21 DONALD CAMERON

ANIMAL INTELLIGENCE[1]

FROM the time of Locke downwards the question, How far animals have the power of abstraction? has often been discussed. Locke himself maintained that "the having of general ideas is that which puts a perfect distinction betwixt man and brutes, and is an excellency which the faculties of brutes do by no means attain to." And this view is warmly advocated by Prof. Max Müller and other living thinkers. On the other hand Mr. Romanes, who has made the subject of Animal Intelligence a special study, writes:—"Give a cat or a dog some kind of meat or cake which the animal has never met with, and the careful examination which the morsel undergoes before it is consigned to the mouth proves that the animal has properly abstract ideas of sweet, bitter, hot, nauseous, or in general, good for eating, and bad for eating, *i.e.*, abstract ideas of quality as apart from the object examined—the motive of the examination clearly being to ascertain which general idea of quality is appropriate to the particular object examined."—NATURE, vol. xx., p. 123.

Our first duty in a case like this is to make quite sure of the meaning of the words we employ. Much confusion may be, and has been, introduced into this subject by a lax use of words. Let us consider, then, the several meanings which these terms abstraction and abstract idea may have.

In the first place it seems to me that our most ordinary impressions involve abstraction. An object is capable of affecting us in a number of different ways, but of all these at any given moment we only pay attention to one or two which happen to interest us. The rest are practically non-existent for us. The mind automatically rejects or eliminates them. This is certainly a process of abstraction, but for the sake of clearness I venture to call it *elimination*. By means of elimination we get definite clear-cut mental impressions.

In the second place our general conceptions involve abstraction. A general conception is one which does not stand for a particular object but for a group of objects. It is arrived at by abstracting the essentials and neglecting the unessentials. In the great number of dogs I see around me, there are certain essential characters in the midst of some diversities. As I consider them in the mass, however, the diversities cancel each other in my mind, and I obtain a general conception of a dog. We may for the purpose in hand call this process *generalisation*. The product is *not* a definite and clear-cut image.

In the third place, I may by a process of abstraction consider a quality apart from the things that possess that quality—whiteness for example, apart from white objects, edibility apart from edible things. We will here retain the term abstract idea to denote such qualities, and we will for the present term the process by which they are obtained *isolation*. Of a completely isolated quality no mental image can be formed.

That dogs and the lower animals in general make use of the process I have above termed elimination, cannot I think, for one moment be doubted. For if they do not then we must suppose that they are able mentally to grasp an object in the entirety of its qualities, which is more than the average human being can do. Let us suppose that a dog sees what he believes to be a soaked dog-biscuit. The impression he receives through his eyes at once suggests certain possible olfactory impressions and certain possible gustatory impressions. This of course implies what is commonly called the association of ideas. But there are other possible impressions which might be suggested but probably are not, such impressions, for instance, as may be produced by the hardness, temperature, and weight of the object. These impressions are not suggested, they are eliminated, so to speak. In other words, certain possible impressions are abstracted from certain other possible impressions. Suppose, now, the dog proceeds to smell the biscuit that he has hitherto only seen. If it answers to his expectations he at once begins to eat it. His nose tells him that it is good for eating. If, however, it does not answer to his expectations, if, perhaps, it has received the drippings of a paraffin tin, he turns sorrowfully away. His nose tells him that it is not good for eating. One kind of smell suggests that the biscuit will be pleasant to the taste: another kind of smell suggests that it it will be unpleasant. And the dog, unless he be a very young one, having confidence in his nose, acts upon the suggestions without verification. It is to these suggested impressions that Mr. Romanes applies the term "abstract ideas of quality, as apart from the object examined." And I do not suppose that any one is prepared to deny our dumb companions abstract ideas *in this sense of the term*.

Let us now consider how far we may suppose animals to possess the power of generalisation in the sense in which I have above used this term. A dog lying asleep upon the hearth-rug hears outside the window an unusual footstep. He at once pricks up his ears and gives a half suppressed growl. Must we not suppose that in such a case as this the footstep suggests to the dog the idea of a strange man? And if so, will not the suggestion—of whatever character it might be—be general rather than particular? If it be a mental picture—and we are often told that dogs think only in pictures[1]—must not the picture be generic

---

[1] From a Lecture delivered in Cape Town, South Africa.

[1] I do not know that I quite understand what thinking in pictures means, but I should imagine that sounds and smells entered pretty largely into the current of canine thought. And on the other hand, I should be disposed to think that Spenser and Shakespeare possessed in no slight degree the power

in its character, like Mr. Galton's composite photographs of the average blackguard? And if it be a symbol of some kind, must it not be a symbol that stands for strange man in general, since there is nothing to suggest any particular strange man? But if this be so, and if a general conception is one which stands not for a particular object, but for a group of objects, I do not see how we can deny general conceptions, in this sense of the word, to our four-footed friends. And if the word abstract idea stand, as it is sometimes made to do, for general conception, we must admit, I think, that such abstract ideas are possible for the brute.

We come now to such abstract ideas as result from the process I termed isolation. Are these, too, possible for the brute? I have only to say that it has always seemed to me that when we speak of being able to form abstract ideas of redness, emptiness, justice, and the like, all we can possibly mean is that we can make use of the *words* as symbols in a train of thought I have only to say this to indicate the nature of my answer to this question, I believe such abstract ideas to be impossible for the brute, I believe them to be the outcome of the use of language. We see a plum, and we find that it is round, and blue, and resisting. From these words we form abstract nouns, roundness, blueness, resistance. We then proceed to manufacture a something to which each of these words may answer, and we call that something a quality. Having thus made the quality, the next thing we do is to try and endow it with a separate existence, and to the results of our endeavours we give the name abstract idea. All this is a process which grows out of our use of words under the influence of a developed power of reflection; it is an attempt to conceive a reality-in-thought answering to certain of our symbols. Without a considerably developed use of symbols such a process is impossible. Hence I believe that no animal can form an abstract idea in this sense of the term. He does not possess the only possible means of doing so. To form such abstract ideas as these, is certainly "an excellency which the faculties of brutes do by no means attain to." Here we may agree with Locke and his followers.

May we say, then, that the power of forming abstract ideas, in this sense, is that which distinguishes the intelligence of man from the intelligence of the brute? I think not. There are, I believe, among the lower races of man, whole tribes which are unable to form abstract ideas. Abstract ideas are made possible by language, but the use of language does not necessarily imply the ability to form abstract ideas. Philologists tell us that there are languages or dialects in which no abstract words are to be found. This, however, is certain, that there is no known savage tribe which has no language. Man is the one being that can make use of spoken signs.

But it may be said that, although their language differs from ours, animals too have their language, imperfect it is true but still a language of their own, a means of communication with their fellows. And this is perfectly true. It is true, too, that my dogs can understand *my* language. But all that a dog can communicate to his fellow—all that I can communicate to my dog is a sign which he has learnt to associate with certain feelings or with certain actions to be performed. The communication deals, too, with immediate feeling or action; its sphere is the here and the now. There can be no doubt that dogs associate with barking in certain tones, special emotional states in their companions. In fact it is probable that dogs can in this way communicate with each other a wide range of states of feeling. But these states are present states, not states past or future. They are their own states, not the states of others. A dog can call his companions' attention to a worriable cat, or he may have his attention roused by my exclaiming "cat." But no dog could tell his companion of the successful "worry" he had just enjoyed or suggest that they should go out for a "worry" to-morrow morning. And here we come upon what seems to me the fact which raises man so immeasurably above the level of the brute. *The brute has to be contented with the experience he inherits or individually acquires. Man, through language spoken or written, profits by the experience of his fellows.* Even the most savage tribe has traditions extending back to the father's father (Sproat). And the civilised man—has he not in his libraries the recorded results of many centuries of ever widening experience and ever deepening thought? Thus it is that language has made us men. By means of language and language alone has human thought become possible. This it is which has placed so enormous a gap between the mind of man and the mind of the dog. Through language each human being becomes the inheritor of the accumulated thought and experience of the whole human race. Through language has the higher abstract thought become possible.

But though I look upon the difference between human intelligence and brute intelligence as very great, *I do not believe that there is any one faculty which all men possess and which no brute possesses.* I have already stated my views on the subject of abstraction, and to what I have said I have nothing now to add. But concerning the converse process of *construction* or object—forming a few words may be said. Let me first explain what I mean by construction. Our conception of an object is the result of a synthesis of its qualities. But this synthesis is, I imagine, of two kinds. There is a synthesis by immediate association, and a synthesis by reflection. When a dog sees before him a soaked dog-biscuit, his conception of the object is a synthesis by immediate association. The sight of the biscuit at once suggests by association a certain smell and taste. The object he mentally constructs is built up of these three, sight, smell, and taste. All other properties are rejected or eliminated. Now, suppose the dog capable of reflecting thus—the biscuit is light enough to carry, soft enough to bite, cool enough not to burn my mouth—he would then add to his synthesis by immediate association, a further synthesis by reflection, and would construct a more complete object. By the synthesis by reflection, in fact, all those qualities are added which are unconsciously eliminated in the immediate construction by association. I do not imagine that brutes have sufficient power of reflection to affect to any great extent this further synthesis. Indeed I imagine that savages and young children do not habitually go further than the construction by association. The further process has been added mainly under the influence of a developed language. The *word* groups around itself not only the cluster of associated ideas which make up the ordinary unreflecting conception of the object it symbolizes, but also all those further ideas which are the result of scientific study. The word is the peg upon which we hang those abstract qualities which by means of words we have isolated.

C. LLOYD MORGAN

AINO ETHNOLOGY

THE already somewhat voluminous literature of the Aino race has been recently increased by two valuable memoirs by competent original observers.[1] Hence, if neither Dr. Scheube nor Herr von Siebold has anything very new to tell us, it may be fairly concluded that most of the available data have now been collected. Extended research in the unexplored districts of Yeso may doubtless bring to light some further interesting facts

---

of thinking in pictures—pictures far truer and more beautiful than even they could describe in words. All processes of thought, in fact, are carried on by association. And in the chain of association there may be links of all kinds furnished by all the senses we possess. All that we can say with regard to man is that he adds to the natural symbols which form links in this chain of association, certain arbitrary symbols of his own manufacture.

[1] "Die Ainos," von Dr. B. Scheube, Yokohama, 1882; and "Ethnologische Studien über die Aino auf der Insel Yeso, von Heinrich von Siebold, Berlin, 1881.

bearing on the physical and social characteristics of the aborigines. But no fresh discoveries of any moment are likely to be made, nor is it at all probable that anything will be brought forward in the least calculated to shake the general conclusions already arrived at.

Until the appearance of Herr Rein"s large work on Japan,[1] one of the most universally-accepted of these conclusions was that, whatever be their affinities, the Ainos must certainly be separated from the Mongolic connection. No little surprise was accordingly produced by Rein's attempt to affiliate them to the surrounding members of the Yellow Race. But it was soon seen that his arguments, apparently inspired by a love of paradox, were sufficiently refuted by the very illustrations of the Aino type introduced into his work. It is therefore satisfactory to find that his views meet with no countenance in these memoirs, the authors of which emphatically reject the Mongol theory. "I cannot discover,'' writes Dr. Scheube. "the Mongolic type in the Ainos. The great development of the hair, the disposition of the eyes, the nasal formation, the moderate breadth between the cheek bones, the absence of prognathism, are all so many traits separating them from the Mongolians" (p. 3). So also Siebold: "The whole physiognomy and configuration of the Ainos has little of a Mongol character. The general impression they made on me was rather that of Europeans living under unfavourable conditions. I had a feeling, which also seemed to dawn upon them, that I was not associating with an alien race; and however strange it may appear, I cannot but compare the Ainos with the Russian peasantry" (p. 10).

Topinard had already declared that "the Ainos of Japan, the Miaotze, and the Lolos of the province of Yunnan belong, in my opinion, to the European group" ("Anthropology," p. 476). And it is extremely suggestive to find this writer also comparing them with the inhabitants of the Moscow district. "Chose absolûment singulière, ce type célèbre des Ainos, avec ses traits aujourd' hui bien connus et sa barbe inculte, serait celui de certains paysans russes des environs de Moscou" (*Rev. d'Anthrop.*, 1879, p. 637). The same resemblance with the Russians has no doubt been detected in the Itelmen people of Kamchatka and among some of the Ghiliak tribes of the Lower Amur districts. But the presence of the Aino element has long been suspected in both of these regions. Most of the Kurile islands are still peopled by them, while the nomenclature of the whole archipelago is distinctly Aino, as shown by the term *Moshir = Island*, reaching as far north as *Para-moshir*, close to Cape Lopatka, at the extremity of Kamchatka. In the Lower Amur valley also W. G. Aston speaks of an Aino tribe called Santal or Sandan (*Church Missionary Intelligencer*, August, 1879); Siebold (p. 12) refers the Kilengs and Kachengs of the neighbouring Hingpu River to the same connection, and also mentions certain Aino communities about Castries Bay, over against Sakhalin. The southern portion of this island is itself Aino domain, although, since its annexation to Russia, a considerable emigration has set in towards Yeso. In Nippon the Japanese records bring the Aino at least as far south as the latitude of Tokio, whence they were gradually driven north or absorbed, leaving traces of their presence both in the Japanese type and in the geographical terminology of the northern provinces of the main island. Lastly, the national traditions point to North-East Asia as the region whence they migrated to their present homes.

It is thus sufficiently evident that the Mozin (Mao-chin, *i.e.* "Hairy Men"), as both the Chinese and Japanese often call them, were formerly far more widely diffused than at present. And this renders more intelligible the feeling with which the Ainos, *i.e.* "Men,'' as the word means in their language, at one time regarded themselves as the centre of the universe, a feeling embodied in the old national song: "Gods of the sea, open your divine eyes. Wherever your eyes turn, there echoes the sound of the Aino speech.''

This speech, as might be expected, shows not the slightest resemblance to the Japanese, or to any of the idioms current amongst the surrounding Mongoloid peoples. Siebold, who points at a relationship with the Itelmen, a relationship denied by the elder Siebold, has collected copious materials for its study, but, pending the publication of these materials, the student must rest satisfied with the somewhat meagre account contained in Dr. Scheube's memoir. From this the Aino language appears to be of an extremely primitive type, scarcely on a higher level than was the extinct Tasmanian, and, like it, supplementing its scant relational forms by means of signs and gestures. Thus the ideas of affirmation and negation, for which there are no distinct terms, are respectively conveyed by a nod and a shake of the right hand or else of the head. Winking also plays a large part in supplementing grammatical concepts.

There are, of course, no nominal or verbal inflexions beyond a sort of passive restricted to some verbs, and formed by combining the root with what appears to be the substantive verb prefixed. Thus KIK = to strike; *ac̄n-kik* = to be struck, from *an* or *ana* = to be (?). The parts of speech seem to be restricted to the noun, adjective, verb, a few adverbs and pronouns, of which latter the first and second only have been developed. This absence of a third personal pronoun places Aino at the very bottom of the scale in linguistic evolution, and this low position is further shown by its absolutely isolating condition. Although polysyllabic, it has not yet reached the agglutinating stage, so that each word in the sentence remains isolated, as in Chinese. Thus:—

Koandi dándo oman = I go to-day.
Koandi núman oman = I go yesterday.
Koandi inháta oman = I go to-morrow.

But it differs from the Indo-Chinese, and approaches the American polysynthetic system in the extent to which it has carried word-building. This important feature is not noticed by Scheube, who is no philologist, but attention has been called to it by Dr. A. Anuchin, in an able paper on the Ainos in the *Memoirs* of the Russian Society of Natural Science, vol. xx., Supplement, Moscow, 1877. A curious instance is the word *Kamui*, the general term for God, or any minor deity, which both Scheube and Siebold seem disposed in some way to connect with the Japanese *Kami*. In reality it is an Aino compound form derived from Kam-trui = "flesh-strong," that is, rich in flesh. Before their contact with the Japanese the great god of the Ainos was the bear, as it still is of the Ghiliaks, and some other Amur tribes. As is well known from Miss Bird's "Unbeaten Tracks,'' and other sources, this animal is not only worshipped, but also killed and eaten at certain periods, and with much ceremony, by all these primitive peoples. To be rich in flesh came thus to be regarded as the highest attribute of the deity, and when the etymology was forgotten, Kamui was easily generalised as a name applicable to any god. Have the divinities of Aryan mythology any less realistic origin?

It may be incidentally remarked that in these memoirs Miss Bird's very graphic description of the physical features, habits, and customs of the natives of Yeso, is fully confirmed in nearly all their details. An important exception is the texture of the hair, which according to her, "never shows any tendency to curl." But the hair of seven Ainos from different parts of Yeso, examined by Dr. Scheube, is, with one exception, described as more or less "gelockt,'' that is, "curled" or "ringletted.'' Of one the hair is said to be "überall gekräuselt,'' frounced or frizzled all over. Except amongst the Aborigines of the south-west Chinese highlands, one may travel over the whole of China, Tibet, and Mongolia, without meeting a single case of even wavy, much less curled hair.

---

[1] "Japan nach Reisen und Studien,'' 2 vols., Leipzig, 1881.

And as the quality of the hair is a much more durable feature than the complexion, or almost any other physical trait, the necessity of separating the Ainos from the Mongolic stock becomes all the more obvious. If all this, combined with a distinct orthognathism, mesocephalic head (index No. 76), a light complexion, often scarcely darker than that of Europeans, brown iris, large well-shaped nose, and low cheek bones, is not sufficient to affiliate them to the Caucasic stock, then anthropologists must discover some other sufficiently differentiated physical type with which to group them. That various branches of the Caucasic race reached the East Asiatic seaboard in prehistoric times has been pointed out by this writer in a recent paper on the Koreans (see NATURE, vol. xxvi , p. 344). From Korea to the Japanese Archipelagos, the transition is easy, although it is not pretended that the line of migration necessarily followed this route. But enough has perhaps been stated to show that there is nothing extravagant in the theory of a Caucasic origin of the Aino race. Some of the intermediate links between them and their western kinsmen have already been brought to light. The others must be looked for in the still unexplored uplands of South-west China and Further India.

It is also to be noticed that the Ainos can only in a relative sense be regarded as the Aborigines of Yeso and Nippon. Scheube tells us that they are entirely ignorant of the potter's art (p. 11). But abundance of ancient pottery, often highly ornamented, has been found in many parts both of Hondo and Yeso. These remains are referred by the Ainos themselves to the extinct Koro-pok-Guru, or "People of the Hollows," their precursors in Yeso, who dwelt in huts built over pits, and who had a knowledge of pottery. The Japanese also refer the pits found on an island near Nemuro, north-east coast of Yeso, to the Kohito, a dwarfish race, said to have been exterminated by the Ainos, and apparently identical with the Koro-pok-Guru. It becomes a question whether with these potters, rather than with the Ainos, are to be associated the earthenware and other prehistoric remains found by Milne in the kitchen middens of the Tokio district and other parts of Japan. These remains show clear traces of cannibalism, a practice which seems entirely alien from the mild and inoffensive disposition of the Ainos.

But however this be, the present Aborigines seem destined at no distant date to disappear like their predecessors. The total number of full blood Ainos is estimated by Scheube at about 17,000 for Yeso, to which must be added, perhaps, 1000 or 1500 for Sakhalin and the Kuriles. Siebold, however, thinks that one-third of the inhabitants of Yeso, say 45,000 altogether, are either pure or half-caste Ainos. But the former are known to have decreased in the government of Sapphoro from over 16,000 in 1871, to 13.326 in 1878, while the latter seem to be correspondingly on the increase. The result is inevitable—the effacement of the Ainos as a distinct nationality, and their ultimate absorption in the dominant race. The process that has been completed in Nippon is in rapid progress in Yeso.

A. H. KEANE

ON A NEW ARC ELECTRIC LAMP[1]

ELECTRIC lamps on the arc principle are almost as numerous as the trees in the forest, and it is somewhat fresh to come upon something that is novel. In these lamps the carbons are consumed as the current flows, and it is the variation in their consumption which occasions the flickering and irregularity of the light that is so irritating to the eyes. Special mechanical contrivances or regulators have to be used to compensate for this destruction of the carbons, as in the Siemens and Brush type, or else refractory materials have to be combined with the carbons, as in the Jablochkoff candle and in the lamp Soleil. The steadiness of the light depends upon the regularity with which the carbons are moved towards each other as they are consumed, so as to maintain the electric resistance between them a constant quantity. Each lamp must have a certain elasticity of regulation of its own, to prevent irregularities from the variable material of carbon used, and from variations in the current itself and in the machinery.

In all electric lamps, except the Brockie, the regulator is in the lamp itself. In the Brockie system the regulation is automatic, and is made at certain rapid intervals by the motor engine. This causes a periodic blinking that is detrimental to this lamp for internal illumination.

M. Abdank, the inventor of the system which I have the pleasure of bringing before the Section, separates his regulator from his lamp. The regulator may be fixed anywhere, within easy inspection and manipulation, and away from any disturbing influence in the lamp. The lamp can be fixed in any inaccessible place.

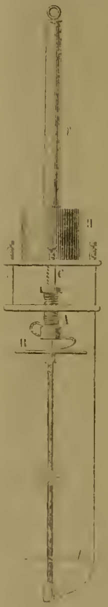


FIG. 1.

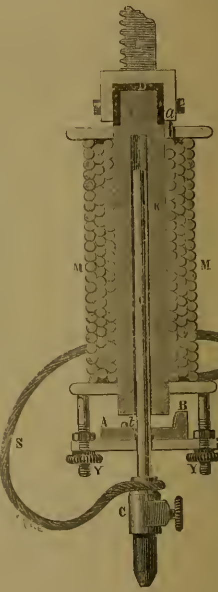


FIG. 2.

The Lamp (Figs. 1, 2, and 3).—The bottom or negative carbon is fixed, but the top or positive carbon is movable, in a vertical line. It is screwed at the point C to a brass rod, T (Fig. 2), which moves freely inside the tubular iron core of an electromagnet, K. This rod is clutched and lifted by the soft iron armature, A B, when a current passes through the coil, M M. The mass of the iron in the armature is distributed so that the greater portion is at one end, B, much nearer the pole than the other end. Hence this portion is attracted first, the armature assumes an inclined position, maintained by a brass button, *t*, which prevents any adhesion between the armature and the core of the electromagnet. The electric connection between the carbon and the coil of the electromagnet is maintained by the flexible wire, S.

---

[1] Paper read at the British Association, Southampton. Revised by the Author.

The electromagnet, A (Fig. 1), is fixed to a long and heavy rack, C, which falls by its own weight and by the weight of the electromagnet and the carbon fixed to it. The length of the rack is equal to the length of the two carbons. The fall of the rack is controlled by a friction break, B (Fig. 3), which acts upon the last of a train of three wheels put in motion by the above weight. The break, B, is fixed at one end of a lever, B A, the other end carrying a soft iron armature, F, easily adjusted by three screws. This armature is attracted by the electromagnet, E E (whose resistance is 1200 ohms), whenever a current circulates through it. The length of the play is regulated by the screw, V. The spring, L, applies tension to the break.

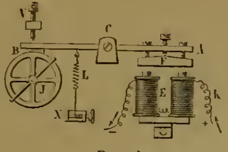


Fig. 3.

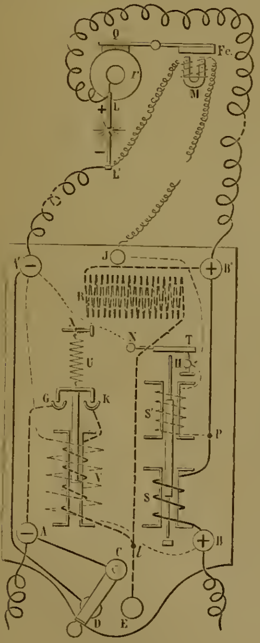


Fig. 4

The Regulator.—This consists of a balance and a cut-off.

The Balance (Figs. 4 and 5) is made with two solenoids, S and S', whose relative resistances is adjustible. S conveys the main current, and is wound with thick wire having practically no resistance, and S' is traversed by a shunt current, and is wound with fine wire having a resistance of 600 ohms. In the axes of these two coils a small and light iron tube (2 m.m. diameter and 60 m.m. length) freely moves in a vertical line between two guides. When magnetised it has one pole in the middle and the other at each end. The upward motion is crontrolled by the spring N T. The spring rests upon the screw, H, with which it makes contact by platinum electrodes. This contact is broken whenever the little iron rod strikes the spring, N T.

The positive lead from the dynamo is attached to the terminal, B, then passes through the coil, S, to the terminal, B', whence it proceeds to the lamp. The negative lead is attached to terminal A, passing directly to the other terminal, A', and thence to the lamp.

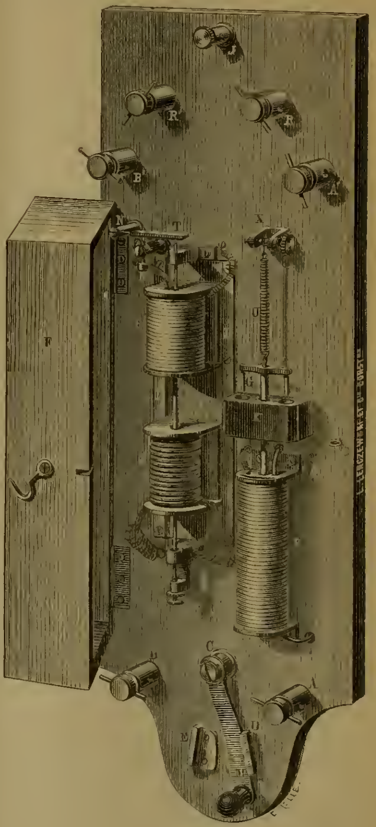


Fig. 5

The shunt which passes through the fine coil, S', commences at the point, P. The other end is fixed to the screw, H, whence it has two paths, the one offering no resistance through the spring, T N, to the upper negative terminal, A'; the other through the terminal, J, to the electromagnet of the break, M, and thence to the negative terminal of the lamp, L'.

The Cut-off.—The last part of the apparatus (Fig. 4) to be described is the cut-off, which is used when there are several lamps in series. It is brought into play by the switch, C D, which can be placed at E or D. When it is at E, the negative terminal, A, is in communication with the positive terminal, B, through the resistance, R, which equals the resistance of the lamp, which is therefore out of circuit. When it is at D the cut-off acts automatically to do the same thing when required. This is done by a solenoid, V, which has two coils, the one of thick wire offering no resistance, and the other of 2000 ohms resistance. The fine wire connects the terminals, A′ and B. The solenoid has a movable soft iron core suspended by the spring, U. It has a cross piece of iron which can dip into two mercury cups, G and K, when the core is sucked into the solenoid. When this is the case, which happens when any accident occurs to the lamp, the terminal, A, is placed in connection with the terminal, B, through the thick wire of V and the resistance, R, in the same way as it was done by the switch, C D.

Electrical Arrangement.—The mode in which several lamps are connected up in series is shown by Fig. 6. M is the dynamo-machine. The + lead is connected to B_1 of the balance, it then passes to the lamp, L, returning to the balance, and then proceeds to each other lamp, returning finally to the negative pole of the machine. When the current enters the balance it passes through the coil, S, magnetising the iron core and drawing it downwards (Fig. 4). It then passes to the lamp, L L′, through the carbons, then returns to the balance, and proceeds back to the negative terminal of the machine. A small portion of the current is shunted off at the point, P, passing through the coil, S′, through the contact spring, T N, to the terminal, A′, and drawing the iron core in opposition to S. The carbons are in contact, but in passing through the lamp the current magnetises the electromagnet, M (Fig. 2), which attracts the armature, A B, that bites and lifts up the rod, T, with the upper carbon a definite and fixed distance that is easily regulated by the screws, V V. The arc then is formed, and will continue to burn steadily as long as the current remains constant. But the moment the current falls, due to the increased resistance of the arc, a greater proportion passes through the shunt, S′ (Fig. 4), increasing its magnetic moment on the iron core, while that of S is diminishing. The result is that a moment arrives when equilibrium is destroyed, the iron rod strikes smartly and sharply upon the spring, N T. Contact between T and H is broken, and the current passes through the electromagnet of the break in the lamp. The break is released for an instant, the carbons approach each other. But the same rupture of contact introduces in the shunt a new resistance of considerable magnitude (viz. 1200 ohms), that of the electromagnets of the break. Then the strength of the shunt current diminishes considerably, and the solenoid, S, recovers briskly its drawing power upon the rod, and contact is restored. The carbons approach during these periods only about ·01 to ·02 millimetre. If this is not sufficient to restore equilibrium it is repeated continually, until equilibrium is obtained. The result is that the carbon is continually falling by a motion invisible to the eye, but sufficient to provide for the consumption of the carbons.

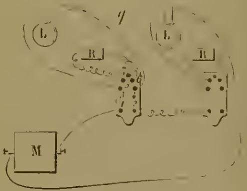


Fig. 6.

The contact between N T and H is never completely broken, the sparks are very feeble, and the contacts do not oxidise. The resistances inserted are so considerable that heating cannot occur, while the portion of the current abstracted for the control is so small that it may be neglected.

The balance acts precisely like the key of a Morse machine, and the break precisely like the sounder-receiver so well known in telegraphy. It emits the same kind of sounds, and acts automatically like a skilled and faithful telegraphist.

This regulation, by very small and short successive steps offers several advantages: (1) it is imperceptible to the eye; (2) it does not affect the main current; (3) any sudden, instantaneous, variation of the main current does not allow a too near approach of the carbon points.

Let now an accident occur, for instance, a carbon is broken. At once the automatic cut-off acts, the current passes through the resistance R instead of passing through the lamp. The current through the fine coil is suddenly increased, the rod is drawn in, contact is made at G and K, and the current is sent through the coil, R. As soon as contact is again made by the carbons, the current in the coil S is increased, that of the thick wire in V diminished, and the antagonistic spring, U, breaks the contact at G and K. The rupture of the light is almost invisible, because the relighting is so brisk and sharp.

I have seen this lamp in action, and its constant steadiness leaves nothing to be desired. W. H. PREECE

THE SANITARY INSTITUTE

THE Inaugural Address delivered by Captain Douglas Galton at the opening of the Congress of the Sanitary Institute of Great Britain at Newcastle-upon-Tyne, traces the growth of the more important questions relating to public health and to the prevention of disease from remote times down to recent date, and it is, both historically and otherwise, of much interest. Questions of public health have for many years past received increasing attention in this and other countries, and the energies of some of the ablest intellects have been devoted to the investigation of the various circumstances which tend to injure the health of communities. Some have dealt with the subject from a purely scientific point of view, others have given their attention especially to the defects in works of construction, such as systems of sewerage and water-supply, which have led to the spread of disease, and many physicians have devoted themselves exclusively to those branches of medical science which deal with preventive as opposed to curative medicine. Captain Galton refers to many of these researches, and shows how they have tended to secure for us our present knowledge. Dr. Tyndall's well-known investigations as to the existence of low forms of life in the dust contained in air, and his studies on putrefaction are recorded, as also Dr. Bastian's and Mr. Lister's kindred labours, and the practical applications to which they may be put. The several discoveries as to the connection of disease with definite organisms are noted; Professor Koch's recent contributions as to the organisms associated with tubercular disease closing this subject, in point of time. M. Pasteur's discoveries in connection with fowl-cholera and anthrax in cattle, and the associated question of the attenuation of the infectious property of the virus of these diseases, as the result of the processes to which they are subjected are dealt with in some detail. As to accepting M. Pasteur's conclusions in their entirety, it may however be desirable to await further experiments, the more so as certain investigations of Dr. Klein, an account of which has recently been submitted by the Local Government Board to the Veterinary Department of the Privy Council, have tended to conclusions adverse to the general adoption of M. Pasteur's proposal to inoculate cattle with an attenuated virus as a protection against anthrax. Knowledge as to these subjects is shown in the address to be rapidly increasing, but it is maintained that the science of the prevention of disease advances quite as rapidly as the knowledge relating to its causation. Thus, the application of systems of sewers is shown by statistics to have led to a great decrease in enteric or typhoid fever, both in this and other countries, and it is rightly contended that where a similar result has not followed on such provision, defective and faulty methods of construction, and not the systems as such, must be held responsible. The improvement in the water-supplies for our towns and villages has in like manner led to much saving of life and health, but dangers still lurk even in our modern systems of supply, and some of them are extremely difficult of detection. As to this subject Captain Galton says he is disposed to think that there has never been a well-proved case of an outbreak of disease resulting from the use of drinking water, where the chemist would not unhesitatingly on analysis have condemned the water as an impure source. The inference here implied must unquestionably be regarded as considerably in advance of that which our more eminent chemists themselves would lay claim to. Indeed, Dr. Frankland has distinctly admitted that chemical analysis is unable to detect those small quantities of morbific matter which are capable of conveying disease, and he has himself mingled choleraic dejecta with water without being able to detect any noteworthy chemical alteration in its quality. The standard which should be aimed at in this matter of water-supply is the same as that advocated by Captain Galton in other matters such as sewerage, ventilation, &c., and that is to get rid of all conditions involving risk, rather than to hope that their influence for mischief may never have opportunity for manifesting itself. The address gives many instances, whether in connection with Indian fairs or elsewhere, to show that scrupulous cleanliness should be the aim of sanitarians, and this is at least as desirable in connection with water services and water-courses as elsewhere.

The address having been delivered at Newcastle-upon-Tyne, it was but natural that frequent reference should have been made to sanitary administration in that borough, and to the results attendant upon it. The need for the isolation of infectious diseases is a matter of public concern, which called for and received attention, and it is satisfactory to note from the recently issued Report of the Medical Officer of the Local Government Board, that a considerable proportion of the sanitary authorities in England have already recognised the necessity for making some provision for the removal of the infectious sick from amongst crowded communities. But it is also evident that the accommodation provided should be of an efficient character. At Newcastle there is hospital provision for the infectious sick, but we fear that even whilst the Congress is sitting, the inadequacy of the accommodation available there is causing anxiety to those who are responsible for the health of the borough. The extension of sanitary hospitals to every part of the kingdom is much to be desired, and the suspicion of their possible influence for evil which is adverted to in the address, need not in any way hinder action in this direction. The only disease which has ever been alleged to extend from such hospitals to the surrounding neighbourhoods is small-pox, and even that disease is not suspected of having any such influence except when a large number of patients are aggregated together. The very essence of these hospitals is to have them in actual readiness, so that first attacks being at once isolated any further spread is prevented; and if by any chance this becomes impossible, it is, to say the least, doubtful whether, the disease having once extended, we have not in vaccination an even more potent method of prevention than isolation can at such a stage afford. The compulsory notification of infectious diseases will some day come powerfully to the aid of isolation as a measure of prevention, but public opinion as yet hardly appears ripe for any general measure to that effect.

In the concluding portion of his address Captain Galton endeavoured to convince his audience of the truth of the aphorism that public health really means public wealth. The advantages of dealing efficiently with the refuse of the population by sewage farms and otherwise was pointed out, and some of the results indicated went clearly to show that after all filth is but matter in a wrong place. The saving of life and health amongst persons inhabiting our model dwellings and improved lodging-houses was also shown to be striking, and it needs but little argument to prove that a distinct pecuniary advantage accrues to the community which can, by providing proper dwellings for the poor, retain amongst them, and in health, the bread-winners of each family. A large death-rate always means a heavy sick-rate and an increased poor-rate, and there is no form of death-rate which indicates a greater loss to a district than that which results from those infectious diseases which find their victims amongst the youth and adult members of the population. Fortunately it is these diseases above all others which are most easily prevented by the adoption of an intelligent and efficient sanitary administration.

NOTES

WE regret to have to record the death, at the age of forty-three years, of M. Georges Leclanché, the inventor of the oxide of manganese constant elements, which are used so largely all over the world.

DR. OSCAR DICKSON has purchased and presented to the Botanical Museum at Upsala the magnificent collection of Scandinavian mosses and algæ which the two Swedish naturalists, Messrs. J. and C. Hartman had collected during sixty years. The three botanical collections which form the basis for the study of the Scandinavian flora, viz., the Fries, Hahlenberg, and Hartman are now, by this last donation, in the possession of the University of Upsala.

THE inauguration of the Becquerel statue took place on Sunday at Chatillon-sur-Loing, a small country town of the Montargis arrondissement, in the department of Loiret, where the eminent electrician was born in 1788, and where his family are still living. The statue represents Becquerel holding in his hands the small apparatus of which he made use for producing by electrical agencies his artificial crystals. On the pedestal is carved the names of the principal battles which Becquerel fought when in the French army, which belong mostly to the campaign of 1813, especially the siege of Saragossa. M. Cochery, the Minister of Postal Telegraphy, who is the representative of Chatillon-sur-Loing in the French Lower House, delivered the inaugural speech—an eloquent address, summarising the principal discoveries of Becquerel, and insisted on the services rendered by him to the cause of telegraphy. M. Dumas, the President of the Committee for erecting the statue, having been unable to attend the meeting, sent a written address, which was read on his behalf by M. Daubree, Director of the School of Mines. In this eloquent address the Perpetual Secretary of the Academy of Sciences presented a picture of the results obtained by modern industry and drew a most ingenious parallel between the Greeks and Romans erecting statues to demigods, and the modern nations conferring the same honours on the real benefactors of mankind. He eulogised Guillaume, the eminent artist, whose masterpiece was offered to the inhabitants of Chatillon to commemorate the life of a great man. M. Fremy advocated the cause of the Museum. He reminded the audience that just fifty years ago the lectureship occupied by

Becquerel had been created expressly for him, in accordance with a recommendation of the Academy of Sciences. To give a proof of the exceptional activity exhibited by Becquerel up to the age of ninety years, M. Fremy stated that he had published during his life not less than 529 works or papers in scientific periodicals. M. Barras, Perpetual Secretary of the French Agricultural Society, reviewed the services conferred by Becquerel by his works on agriculture. M. Berthelot, a member of the Municipality, returned thanks to the *savants*, and the proceedings terminated by a banquet given to the scientific guests by the Becquerel family. All the speakers made allusion to the merits of M. Becquerel the younger and of his son, now *répétiteur* to the Polytechnic School.

THE burthen of the address of Mr. Woodall, M.P., in the Education Department of the Social Science Congress at Nottingham, was that without science in our systems of education, our industries are bound to wane before those of other countries where a scientific system of technical education exists. He showed what is being done in Germany and France in this respect, and how much headway we have to make before we can reach the standpoint of these countries. In this department Mr. Rowland Hamilton read a paper on the endowment of research. "As to the endowment of the more special forms of research as more commonly understood," he said, "there is hardly any limit which it is desirable to assign to it provided due assurance is given that the work desired is efficiently carried out. The services thus rendered are pre-eminently of general and national importance, and must be provided for by national expenditure. The economic doctrine of supply and demand as regards the interchange of individual services is wholly inapplicable to the question. The difficulty lies in the administration of the funds devoted to such purposes so as to insure that they are given to those duly qualified to use them. The method of State grants in aid, dispensed through the agency of existing societies and learned bodies who have earned a title to public confidence, might be largely developed with the greatest advantage and the relative functions of the Government and of such societies in their relation to this subject were discussed. The multiplication of 'idle fellowships' had a demoralising tendency. While any undue interference on the part of the central administration was to be altogether deprecated, it was essential to reserve to the State an ultimate and *quasi* judicial control, which would best secure that publicity and definite responsibility which are the best safeguards against abuses in any direction." In speaking on the subject of technical training Mr. Hamilton remarked that it was not necessary to teach special crafts in primary schools, but it was most desirable that a general scientific groundwork in technical knowledge should be included in a system of national education.

THE Iron and Steel Institute meeting at Vienna has evidently been a great success. Several subjects of great manufacturing importance have had the benefit of being discussed by men experienced in various methods; and the hospitality towards the English visitors has been profuse.

WHEN Admiral Mouchez received the news of the observations made by Thollon of the new comet he telephoned it to the Havas agency, and it was telegraphed by them to every paper in France. This is the first time that this organisation has been used in France for scientific purposes, and for the future it will be employed for any notable celestial occurrence.

WE are pleased to learn that the result of the letter which appeared in our columns a few weeks ago has been that a short course of popular science lectures has been planned, to be given on Friday evenings at the Victoria Hall, Waterloo Road. If this experimental course is successful it is proposed to extend it. Admission is one penny (or threepence and sixpence for balcony seats), and the hall will seat 2500.

MESSRS. KEGAN PAUL, TRENCH, AND CO. will shortly add to the International Scientific Series, translations of Ribot's work on "Diseases of Memory, an Essay in the Positive Psychology," and of N. Joly's work on "Man before Metals." These will be followed by Mr. Robert H. Scott's "Elementary Meteorology," and Prof. Sheldon Amos's "Science of Politics."

WE have received three new parts of the "Encyclopædia der Naturwissenschaften," published by Trewendt, of Breslau—parts 5 to 7 of the second division. Part 5 contains the continuation of Kenngott's Word-book of Mineralogy, Geology, and Palæontology; in this we find two specially interesting articles by Lasaulx—on Continents and Delta Formations. In the 6th part we have the Word-book of Chemistry by Ladenburg and Collaborateurs. One of the leading articles in this part is that on Alkaloids, by Jacobsen, of Rostock. The 7th part is devoted to Pharmacological Botany, by Wittstein.

"THE Tropical Agriculturist" is the title of a monthly record of information for planters of coffee, tea, cocoa, cinchona, india-rubber, sugar, tobacco, cardamoms, palms, rice, and other products suited for cultivation in the tropics, published by Messrs. A. M. and J. Ferguson, of Colombo. Haddon and Co. are the London agents.

AFTER an address by the President, Mr. Shadworth H. Hodgson, LL.D., on October 9, and a paper on Spinoza on October 23, the Aristotelian Society propose devoting the meetings in November and December to a series of papers on the relation of Leibnitz and Wolf, and Locke, Berkeley, and Hume, to Kant. In January the Society will commence the study of Kant's *Critic of Pure Reason*, which will raise for discussion the validity of the primary concepts of science, and which will occupy the remainder of the session. The meetings will be held at 8, John Street, Adelphi, at 7.30 p.m. Particulars may be obtained from the Honorary Secretary Dr. A. Senier, 1, Bloomsbury Square, W.C.

IT is estimated by Prof. Dufour (*Arch. des Sciences*) that in a disastrous hailstorm on August 21 last year, about 100,000 cubic metres of ice fell in the district of Morges alone in a few minutes, and probably more than 1,000,000 cubic metres in the whole canton de Vaud that afternoon. Yet this is a small matter compared with the terrible hailstorm of July 13, 1788 (regarding which he makes some calculations). He gives some interesting facts, which seem to have been overlooked, in the history of *paragrêles*, or hail-preventers. Old men in the Canton de Vaud remember such apparatus, of lightning-rod character, being set up in several vineyards in 1825; the object being to hinder the formation of hail, by withdrawing electricity from the clouds. A hailstorm in July 1826 devastated, it is said, the best protected vineyards, and the *paragrêles* were then removed. Yet it was on receipt of encouraging and credible testimony from Italy and France (Prof. Dufour shows by extracts) that this brief experiment was made. Considering the distance of hail-forming clouds from the highest *paragrêles*, it is difficult, the author considers, to admit an influence of such apparatus; yet it must be remembered that electricity is "*un veritable fluide à surprises*"; often showing new and unexpected properties. Lately it is said to have been observed in some Swiss cantons, that showers of hail are more rare near forests than in unwooded districts. Prof. Dufour notes this as a matter calling for investigation. A forest may be regarded as a collection of *paragrêles*, and should it be proved to have the influence referred to, the theories which prevailed in 1824 and 1825 would gain new support.

At a recent meeting of the Franklin Institute it was shown by Mr. Grimshaw that the microscope may be of good service in estimating the value of structural materials. It may determine whether or not the material is good enough to warrant trial with the testing machine. The author produced photographs of a chip of timber from a highway bridge that was wrecked two years ago, after a few days of service, through the strain caused by an empty truck; and the poor character of the wood was at once apparent. Such micro-photographs of timber, in fact, show that in the strong specimens, the concentric rings are close in texture and of slight width, and the radial plates frequent, wide, long, and thick, while the reverse is found in the poor material. As a parallel in metal-work, Mr. Grimshaw exhibited two portions of pure Lake copper, one an ordinary ingot, of coarse and crystalline grain, dark red colour, and full of blowholes; the other, cast with proper precautions against oxidation, the grain close and fine, the colour *salmon*, and no blowholes. Tests of tensile strength of sheet and wire from these materials strikingly confirmed the indications of the microscope.

The *Journal* of the Franklin Institute for September contains a fine plate (produced by the phototype process invented by Mr. Jacobi, of Neuendorf-Coblentz), representing the great bell of Moscow, from a photograph recently taken by Mr. Nystrom, who gives some interesting information about the largest ringing bells in the world.

An attempt has been made by Signor Serpieri to connect, in an indirect way, two very dissimilar phenomena, viz., the attraction of the sun and moon, and the periodical revival of vulcanism in its more common manifestations He finds support for his view (*Reale Ist. Lombard.*, August 3) in a recent observation by M. Daubrée in the deep gallery (for the Channel tunnel) made in the Rouen chalk, where it was noticed that the pits showed oscillations of level quite concordant with the varying tide above, the water abundant at high tide, and scanty at low tide; which is easily understood (says M. Daubrée), since all aquiferous strata there pass under the sea. Accepting this variation in the water of terrestrial depths with the sea-level, and knowing, on the other hand, that sea water has a principal part in the activity of volcanoes (as proved by the nature of their products and the immense quantity of aqueous vapour, which cause and maintain eruptions), it is natural, Signor Serpieri says, to conclude that the volcanic activity must present phases agreeing with those of the tide, and thus there appears a certain connection with the age and the position of the moon. Observations of a large number of earthquakes should also present the relation in question, as these are known to be mostly of volcanic origin, and to preferably affect coast regions; and M. Perry observed they were more frequent at syzygies and perigee of the moon. Prof. Bombicci has also observed in some parts of Italy a greater frequency of earthquakes at times of heavy and prolonged rains, which he regards as the exciting cause in such cases; and precisely because not all seismic centres are fed with sea-water, it is vain to expect that the luni-solar influence on earthquakes may be always made out. Thus the anomalies recorded by Schmidt and others may be explained.

The additions to the Zoological Society's Gardens during the past week include a Rude Fox (*Canis rudis*) from Demerara, presented by Mr. W. F. Bridges; three Common Hedgehogs (*Erinaceus europæus*), British, presented by Mr. W. Bayes; two Chimachima Milvagos (*Milvago chimachima*) from Demerara, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Common Barn Owl (*Strix flammea*), British, presented by Mr. G. Paul; a Purple-headed Glossy Starling (*Lamprocolius auratus*) from West Africa, presented by Mr. J. Biehl; a Radiated Tortoise (*Testudo radiata*) from Madagascar, presented by Capt. R. Elwood; a Blue-crowned Hanging Parrakeet (*Loriculus galgulus*) from Ceylon, deposited; a Polecat (*Mustela putorius*), British, a Bengal Pitta (*Pitta bengalensis*) from India, purchased; four Banded Grass Finches (*Poëphila cincta*), bred in the Gardens.

UNWRITTEN HISTORY, AND HOW TO READ IT[1]

II.

But the flint arrow-heads and scrapers, and the use of stone for battle-axes, carry us back to a still earlier chapter of unwritten history, when, for want of knowledge of bronze or any other serviceable metal, our predecessors, like many a savage people of recent or comparatively recent times, had to make use of such materials as readily came to their hands—like stone, wood, and bone—for all ordinary appliances. With relics of this period, which, so far as those made in stone are concerned, are almost imperishable, the soil of this country in many districts abounds. We also find the tools and weapons of this Stone Age in many of the grave-mounds or barrows and beneath the floors of some of our caverns. It is by means of these relics that the history of this period is to be read, but here also much is to be learnt from the early lake-habitations of southern Europe and from the habits of savages in other lands who are unacquainted with the use of metal. It is indeed somewhat remakable that those in so low a stage of civilisation should have been able to furnish themselves with so many and such perfect applicances made of stone. Not only do we find hatchets and adzes of flint and other hard stones, with their edges carefully ground. but chisels, and even gouges or hollowed chisels (though these are rare in Britain), drills or awls, hammers knives, saws, and scraping tools of various kinds. One of the most common of these is made from a flat splinter, or flake of flint, trimmed at the end to a semicircular scraping edge. We still find such tools in use for the purpose of preparing skins; and we have corroborative evidence of their having been in use in old times for some such purpose, in the fact that the semicircular edge is often worn away and rounded in precisely the way that would result from its being used to scrape a soft but gritty substance, such as leather exposed to dust and dirt. Though skins probably formed the principal clothing, the presence of spindle-whorls—the small fly-wheels by which spinning by hand is carried on—in some settlements of the Stone Period, proves that the art of spinning was not unknown, and indeed charred fragments of woven linen cloth have been found in some of the lake dwellings of this age. The stone-using people of that time cultivated wheat, barley, and millet for their bread, which they ground into coarse flour by means of rubbing-stones; they flavoured their cakes with carraway and poppy seeds, and laid up stores of nuts and walnuts, beech-mast and acorns, apples and pears for winter use, and ate all the common wild fruits in their seasons.

All this we learn from the charred remains left at the bottom of the lakes where the pile-dwellings were burnt down. The bones thrown away show that not only did they hunt wild animals of the country, but that they had oxen, sheep, and goats, and probably also pigs, as domesticated animals, and the dog was already their faithful companion. Their weapons for the chase were arrows and spears tipped with flint—the former of which, being cheaper than metal and also liable to be lost, remained in use even when bronze was known. They also possibly made use of the sling. Their axes, like modern tomahawks, seem to have been used both for peaceful and warlike purposes, but in this country at least it is doubtful whether any of the stone battle-axes with a hole for the haft belong to an earlier date than the simplest of the bronze daggers. From an examination of the skulls and bones found in the graves of the Stone and Bronze Periods we are able to form an idea of the size of the men of those days, and of the differences between them. From the objects buried with them we can even form some idea of their religious beliefs and hope of a future state. I must not, however, dwell on the details of these chapters in the unwritten history of man in Britain. I may, however, observe that though we may fix within some centuries the date when bronze began to be employed for cutting-tools, and stone in consequence began to fall in disuse, we are as yet at a loss to say at how early an epoch the use of the stone hatchets with

---

[1] A lecture to the working classes, delivered at the meeting of the British Association for the advancement of science, held at Southampton, *August*, 1882, by John Evans, D.C.L., LL.D., F.R.S., &c. Revised by the Author. Continued from p. 516.

their edges ground or polished first began. The period during which they were exclusively employed has been called the Neolithic or New Stone Period. It has also been called the Surface Stone Period, as the relics belonging to it are usually found upon or near the surface of the ground, and not at a considerable depth below it, like those belonging to an earlier chapter in our history, which actually form constituent parts of extensive geological deposits. There is this also to be observed, that the circumstances under which the stone implements of this periods are found, prove that no very great alteration in the general features of the country has taken place since the time when they were in use. There was the same disposition of hill and valley; rivers ran along much the same course as now, and at much the same level; the same animals frequented the country with but few exceptions, and though there may have been incursions of foreign races of men, we find the Stone Age shading off into the Bronze Age, and the latter into the Iron Age, not many centuries before the Roman occupation Although it is impossible to say for what length of time this Neolithic or Surface Stone Period may have endured in Britain, there is little on the face of the facts which of necessity implies a longer existence for the human race than the six thousand years that used commonly to be assigned to it. In other parts of the world, as for instance in Egypt, there have been circumstances brought to light which prove that the ordinary chronology is insufficient for the history of those countries; and, in addition, there are facts known with regard to the development of language which have led many students to the conclusion that the antiquity of man is much greater than was commonly supposed. And yet five-and-twenty years ago, or less, there was no one who could point to traces of human occupation in Britain of an earlier date than the polished stone instruments. I might, perhaps, make an exception in favour of Mr. John Frere, who, at the beginning of this century, inferred frrom the circumstances under which some stone weapons were found, that they belonged "to a very remote period indeed, even beyond that of the present world."

If it had been my lot to address you in 1858 instead of in 1882, I should myself have assured you that the earliest chapter in our unwritten history was that which related to the polished stone hatchets and the other forms of stone weapons and instruments which are found associated with them. At the same time I should not have agreed with Dr. Johnson, that "all that is really known of the ancient state of Britain is contained in a few pages. We can know no more than the old writers have told us." But within the last twenty years what a lengthened vista of the antiquity of our race has been opened out, and what a marvellous chapter of unwritten history have we not to some extent been able to read!

It is to that chapter that I must now turn, and, in examining it, it will perhaps be best first to state some of the facts which of late years have come to our knowledge, and then to show what inferences have been drawn from them.

Geologists have long been aware that along the valleys of our principal rivers, generally at some height above their present level, and often at some distance from the streams, there are beds of gravel, sand, and brick-earth, frequently containing the remains of land and fresh water shells, and the bones of various animals. That these drift-deposits were not due to the action of the sea is shown by the absence of sea-shells, while the general resemblance of the land and fresh-water shells in them to those in the existing stream and valley prove them to have been deposited by fresh water. The presence in the beds of the bones of land animals is also corroborative of this view; while the fact that several of these beasts, such as the great woolly elephant or mammoth, the rhinoceros, hippopotamus, and reindeer, are of species now extinct, or no longer known in Britain, is suggestive of remote antiquity. In some cases shells and bones have not been found, but the position and character of the beds are such as to prove that they belong to the same class, and are of the same age, as those in which such remains occur. Here at Southampton we are on the tongue of land which separates the valleys of the Test and the Itchen, but the drift-beds in these valleys have not been as yet very carefully examined above Southampton, though at Swathling an elephant's tooth has been found in the gravel. The next valley westward, that of the Avon, which runs into the sea at Christchurch, has been more productive. Along that valley numerous beds of drifted deposits have been examined, and at Salisbury, besides land and fresh-water shells, the bones of elephant, rhinoceros, hyæna, lion, and reindeer have been found in them, as well as those of some other animals, among which the pouched marmot and the Greenland lemming may be mentioned. These are especially indicative of a cold climate, as are also some egg-shells of the wild goose, which now only breeds in northern latitudes. Some of the drift-beds are at a considerable height, as much as 90 or 100 feet above the existing river, but others are at a much lower level. They consist of materials assorted in much the same manner as would be effected by any existing stream—of gravels more or less coarse where probably the current has been strong, of sand where its force has been less, and of brick-earth or mud such as might be deposited by the waters of a flooded river, or brought down the hill-sides by rain. It is impossible to imagine any floods of such magnitude as to fill the valley to the height of 100 feet; but if such floods ever did occur they would certainly not have deposited coarse gravel at the top of the banks of the stream, but at the bottom of its bed. Nor could we expect to find deposits of loam left half-way down the slopes of a river liable to such floods. From these and other grounds we are driven to the conclusion that the beds of drift, which are now 100 feet or more above the existing river, at one time formed a portion of its bed when it ran at a much higher level than at present, and that, by the action of the stream running along it, the valley has since that time been scooped out to its present depth. The climate at the time of the deposit of the high-level gravels appears to have been cold, so that both frost and a much larger rainfall may have assisted the stream in producing greater effects upon the valley than it now does. The river also, when left to itself, and neither watched nor embanked, would be far more liable to floods which might wear away the valley. Under any circumstances the scooping-out to such a depth must have required an enormous amount of time, and it is hard to picture to one's self what the country must have been like in those days when the beds of the rivers at some little distance from the sea were, say, 100 feet above their present level. Here at Southampton we have beds of these old gravels capping the hill at the Common at something like 150 feet above the sea-level, and yet the top of this hill must at the time of their deposit have been the bottom of a valley with hills on either side. As old as the hills is a proverbial phrase, but, compared with the age of the hills at the side of the valley which has disappeared, this hill is a thing of yesterday—

> "The hills are shadows, and they flow
> From form to form and nothing stands.
> They melt like mists the solid lands,
> Like clouds they shape themselves and go."

Some of you will begin to think that I have not kept my promise, but have strayed into the geological past. When, however, I tell you that implements made of flint, as undoubtedly the work of intelligent beings as any Sheffield whittle of the present day, form constituent parts of the gravel of which I have been speaking, and are also found scattered through the sands and loam, you will perceive that I am still within the limits of the unwritten history of the human race.

Before proceeding further with regard to the circumstances under which the implements are found, it will be well to say a few words as to their character and probable uses. Some of them are large flat splinters or "flakes" of flint, detached from a block by a single blow, in the same manner as flakes of flint are still produced in the manufacture of gun-flints. The edges of such flakes are very sharp, so they may have been used as knives. When found in gravel they have usually been much knocked about, but when found in sand or clay the edges often show traces of wear, as if they had been used for scraping bones or some such hard substance as well as for cutting. The more highly wrought implements are sometimes oval, with a cutting edge all round, and sometimes provided with a sharp or rounded point. The oval specimen shown in the diagram was found in a pit at the north end of Southampton Common, and the other two near Barton, between Lymington and Christchurch. These implements are chipped out with considerable skill, and may have been used either as weapons for the chase or for the war, or as tools for cutting, grubbing, or piercing. The extreme point of one of the specimens figured has been worn away at each side, as if it had been used for boring a hole. Some of the instruments may have been mounted with hafts as axes or spears, but of this there is at present no conclusive evidence. The larger number of them appear to be well-adapted for holding in the hand, and it is to be observed that their broad end is usually blunt, and the narrow end sharpened for use; whereas in the instruments of the Surface Stone Period it is nearly always the broad end that is sharpened, and this has often been effected by grinding or polishing the edges, while in the implements of the period we are now considering the edges are never ground. The name by which this period is generally known is the Palæolithic or Ancient Stone Period, though it is sometimes also termed the River-drift Period, as the implements belonging to it are usually found in river-drift. Of the other appliances in use among those who made the large palæolithic implements we can best judge by the remains which have been found beneath the floors of some of the caverns both of England and France, which, however, for the most part probably belong to a somewhat more recent date. In the days when those caverns were occupied as dwellings the reindeer still formed a principal article of food in the South of France. Those who hunted it were sufficiently good artists to carve figures of it in bone, or to engrave them on slabs of slate. Some representations of the elephant have also been found. They carved harpoons in reindeer horn, prepared skins with stone scrapers, and sewed them together by means of bone needles, probably using reindeer tendons as thread. The men, however, who were in this state of civilisation lived at a time when the valleys had been excavated to nearly their present depth, Yet even between them and the people of the Neolithic or Surface Stone Period there appears to be a great gulf—a chapter of unwritten history, which at present we have no means of reading.

Let us now return to the river-drift, and see what more it can teach us. I have told you how on the high ground where now is Southampton Common there are beds of gravel containing water-worn flint implements, and that these beds must in all probability have been deposited in the bottom of a river valley. Farther south we find gravels of a similar character, but at lower levels, forming cliffs of no great height along the sea-shore from Hambley to Alverstoke. These cliffs are now being eaten away by the action of the sea, and among the pebbles spread by the waves upon the shore numerous well-wrought implements have been found, while farther east, at Selsey, there are extensive drift-beds containing remains of the mammoth. Nor are traces of the river, which deposited these beds, wanting on the other side of Spithead, for in the shingle at Bembridge implements of the same kind have been discovered, and Mr. Codrington found a good specimen, some 80 feet above the present sea-level, in gravel on the Foreland at the east end of the Isle of Wight.

It will probably be some little strain upon your powers of imagination for you mentally to fill up the great channel of the sea which we know as Southampton Water, and which now forms the basis of the prosperity of this town, and to picture to yourselves a river flowing in the same direction, spreading out gravels along its changing course at a height considerably above the present sea-level, and yet having its shores frequented by that early race of men who fashioned the implements which we find in the gravels. But I shall have to make a still further demand upon your powers of belief.

I have already spoken to you about the drift-deposits along the valley of the Avon, but I must now take you a little farther west, and call your attention to discoveries which have been made at Bournemouth. There, as many of you no doubt remember, the cliffs are formed of beds of sand and clay belonging to a period a little older, geologically speaking, than the Bracklesham beds which form the subsoil of Southampton. These cliffs are, however, capped with gravel; and in this, also, at a height of more than 120 feet above the sea-level, implements have been found. Farther east, near Boscombe, the height of the gravel is still about 120 feet; at Hengistbury Head it is 90 feet; and at Barton and Hordle, where numerous implements have been found, it is 60 or 70 feet. There can, indeed, be but little doubt that these gravels which now cap the cliffs must originally have been deposited in the bed of a river, and that that river flowed in an easterly direction. But how, it will be asked, can any river have possibly taken such a course? I will ask you, in return, Of what are the Needles at Alum Bay the relics? Are they not the shattered and sea worn remains of an extension of the great chalk ridge of High Down westward from Freshwater? Can you not imagine them still forming part of the down, with other Needles, which have now disappeared, towering still farther to the west? Can you not picture to yourselves the foreland of Ballard Down, on the Dorset coast, and its accompanying pinnacles standing out still farther to the east, and thus in your mind's eye gradually bridge over the gap of fifteen miles, which now exists between the chalk downs of Dorset and those of the Isle of Wight? There must almost of necessity have been a period when these two ranges of downs formed one continuous ridge, and when, in fact, the Isle of Wight was not separated from England by any arm of the sea. At that time the rivers which now discharge their waters at Poole, at Christchurch, at Lymington, and at Exbury, must all have been contributed to form a river the course of which must have been from west to east, in a direction nearly parallel to the chalk downs. Of the bed of this river we have traces in the gravels which now cap the cliffs of our southern coast. The history of the disappearance of this ancient river appears susceptible of being traced. We know not how far the land may have extended to the south of the chalk downs at the time when it first began to flow; but in the course of long ages the never-ceasing wear of the sea, slow but sure in its action, must have effected a breach through the line of chalk downs, and have then more rapidly cut away some of the softer beds to the north, so as to afford a new means of access by which the waters of the river would find a way to the sea. As time went on this breach would become wider and wider, until, as we see at present the whole of the southern slope of the old river valley disappeared for a distance of fifteen miles between Ballard Down and the Needles; while that part of the bed of the old river which still had land to the south was widened out until it became the Solent Sea and Spithead, which now separates the Isle of Wight from the mainland.

I might have given you evidence from which it has been concluded that, at the period when the river gravels containing flint implements were deposited, England was still united to the Continent, and the Straits of Dover did not exist. I might have pointed out the existence of similar implements discovered under nearly similar circumstances in remote quarters of the world. But time will not suffice, and you must be content with my attempt to read this chapter of local history. I must, however, warn you against supposing that, old as may be these relics they represent the first advent of man upon the earth. On the contrary, their similarity in so many regions points to some early home of the human family from which the makers of these flint tools in different countries originally migrated. Of this home, however, as yet no traces have been found. As to the number of years embraced in this chapter of the river-drift it is hard even to speculate. It can only be judged by the changes which have since taken place. We have seen how in the Roman times this part of Britain was, so far as the distribution of land and water is concerned, much the same as at present, and that there can have been but little difference in the days when bronze was in use for cutting-tools or in that lengenthened period when stone did duty for steel. But when we come to this earlier chapter in our history, all is changed. We find on the top of our hills and the capping of our cliffs gravels which must have been deposited at the bottom of rivers, but which testify to the existence of man at the time of their deposit. We find a total change in the animal world of the region; we find that deep valleys have been excavated and river-courses widened out into arms of the sea, and the whole shape and form of the country changed. No wonder if, with so wide a room for speculation, different observers adopt somewhat different readings of this chapter of unwritten history. I have given you my reading of it, in which I see the antiquity of man carried back so far into the dim past, that even Egyptian chronology, extending as it does over thousands of years, appears but to cover a small link in the long chain of human existence—a chain of which the first link has still to be discovered. If you on your part will attempt to check and verify my reading, and study attentively what is still going on under your eyes, it will bring home to you the mighty effects which may arise from the small but ever-active agents, rains and rivers, tide and time; and whether in the end you agree with my reading or not, you will find that you have added a new interest to your lives.

PROFESSOR HAECKEL ON DARWIN, GOETHE, AND LAMARCK[1]

WHEN five months ago the sad intelligence reached us by telegraph from England, that on April 19 Charles Darwin had concluded his life of rich activity, there thrilled with rare unanimity through the whole scientific world the feeling of an irreparable loss. Not only did the innumerable adherents and

---

[1] Lecture given at the Eisenach meeting of the German Naturalists and Physicians.

scholars of the great naturalist lament the decease of the head-master who had guided them, but even the most esteemed of his opponents had to confess that one of the most significant and influential spirits of the century had departed. This universal sentiment found its most eloquent expression in the fact that immediately after his death the English newspapers of all parties, and pre-eminently his conservative opponents, demanded that the burial-place of the deceased should be in the Valhalla of Great Britain, the national Temple of Fame, Westminster Abbey, and that there in point of fact he found his last resting-place by the side of the kindred-minded Newton.

In no country of the world, however, England not excepted, has the reforming doctrine of Darwin met with so much living interest or evoked such a storm of writings, for and against, as in Germany. It is therefore only a debt of honour we pay, if at this year's assembly of German Naturalists and Physicians we gratefully call to remembrance the mighty genius who has departed, and bring home to our minds the loftiness of the theory of nature to which he has elevated us. And what place in the world could be more appropriate for rendering this service of thanks than Eisenach, with its Wartburg, this stronghold of free inquiry and free opinion! As in this sacred spot 360 years ago Martin Luther, by his reform of the Church in its head and members, introduced a new era in the history of civilisation, so in our days has Charles Darwin, by his reform of the doctrine of development, constrained the whole perception, thought, and volition of mankind into new and higher courses. It is true that personally, both in his character and influence, Darwin has more affinity to the meek and mild Melanchthon than to the powerful and inspired Luther. In the scope and importance, however, of their great work of reformation, the two cases were entirely parallel, and in both the success marks a new epoch in the development of the human mind.

Consider, first, the irrefragable fact of the unexampled success which Darwin's reform of science has achieved in the short space of twenty-three years! For never before since the beginning of human science has any new theory penetrated so deeply to the foundation of the whole domain of knowledge or so deeply affected the most cherished personal convictions of individual students; never before has a new theory called forth such vehement opposition and so completely overcome it in such short time. The depicture of the astounding revolution which Darwin has accomplished in the minds of men in their entire view of nature and conception of the world will form an interesting chapter in the future history of the doctrine of development.

In 1863, four years after the publication of Darwin's great work, opening up a new path for the human mind, when at the meeting of naturalists at Stettin, I for the first time openly drew attention to the work, the great majority were of opinion that "nature-philosophical fantasies" of this sort were no proper subject for earnest discussion. An esteemed zoologist pooh-poohed the whole theory as the "harmless dream of a man napping," while another compared it with table-turning and "Odic force." A celebrated botanist maintained that there was not one single fact to support this "untenable hypothesis," but that on the contrary it contradicted all experience, and a noted geologist believed that the passing vertigo would soon inevitably sink into dull sobriety. A well-known physiologist later on spoke of the whole history of filiation as a romance, and an anatomist prophesied that in a few years there would be no more talk of it. In thick-tomed works and in numberless treatises it was demonstrated that Darwin's theory was false from beginning to end, unproved by facts, delusive in its conclusions, ruinous in its consequences. Nay, no further back than five years ago, when in the meeting of Naturalists at Munich (1877) I expounded "the current doctrine of development in relation to the whole body of science," I encountered the most unqualified antagonism in one of our most celebrated naturalists, who even went the length of demanding the exclusion from education of Darwinism as an "unproved hypothesis." I was compelled in my paper on "Free Science and Free Teaching," to take the right of the latter emphatically under my protection.

And of all these damnatory judgments on the part of our numerous opponents, how much remains current at the present day? Nothing. The very number and bulk of their many-sided attacks have only redounded to the completion of our triumph. For the more the immovable citadel of the new theory of nature was attacked from all sides and assailed by weapons of the most varied kind, the more did its undaunted defenders feel called upon to fill up the gaps which here and there disclosed themselves in their inclosing wall of defence. Every charge on the part of the superannuated dogmas went to pieces against the iron panoply of the united experimental sciences. The gifted commander who had discovered the long-sought bond of union for the sciences, and had led the defence under the conception of oneness or monism, was able three years ago, on the celebration of his seventieth birthday, to look with entire satisfaction on the complete victory won by his troops, and with Goethe might say—

> "Es wird die Spur von meinen Erdentagen
> Nicht in Æonen untergehn"[1]

That such is really the case, and that in the evening of his life Darwin was enabled to rejoice in the complete triumph of his good cause is a fact indisputably testified by the present state of the natural sciences. We have only to cast a glance into the numerous periodicals and the most important works in those departments which are more immediately and more integrally affected by Darwin's teaching—zoology and botany, morphology and physiology, ontogeny and palæontology. In these subjects scarcely any work of superior merit now appears which is not penetrated by the idea of natural development. With vanishingly few and unimportant exceptions, almost all investigations start with the assumption of Darwin's fundamental conception, that the form-relationship between different species of animals and plants is rooted in their essential blood-relationship, and that the complicate relations of the organic world are to be explained by the two factors of common origin and gradual transformation.

Darwinism, too, in its more specific sense, the theory of selection, has maintained its ground in the face of all attacks; for this it is which first discovers to us the physiological causes through which the struggle for existence mechanically produces transformation. And if natural selection is by no means the only agent in transformation it at all events still remains its most important instrumen. Darwin, by his discovery of it under the light of artificial selection, solved one of the greatest biological riddles. For the doctrine of "natural selection through the struggle for existence" is nothing less than the final solution of the great problem: "How can forms of organisms constituted for a particular purpose come into being without the aid of a cause acting with a particular purpose? How can an edifice replete with design build itself up without design and without architect?" A question which our greatest critical philosopher, Kant, a hundred years ago, declared to be insoluble.

But in no province of natural science do Darwin's grand achievements appear so conspicuous as the one in which our own investigations revolve, in the wide province of morphology, comparative anatomy, and the history of development. For in morphology, which was also Goethe's special favourite, *all* knowledge that is not merely superficial, depends directly on the recognition of the doctrine of filiation; and here it is, particularly, that by its help the most brilliant results have been attained in the shortest time. The genealogical trees of particular groups of forms, which at the beginning hardly dared venture into the light of day as new-fangled (*heuristische*) hypotheses, are now, in the case of many organic groups, completely established facts. To cite but a few examples, no competent zoologist any longer calls in question the descent of horses from tapir-like palæotheria, of ruminant animals from swine-like anoplotheria, of birds from lizard-like reptiles. Nor does any one any longer doubt that all higher air-breathing vertebrates have their origin in lower gill-breathing fishes. The most important and most disputed, however, of all hypotheses of descent, that, namely, which derives man from ape-like mammals, has of late years, in consequence of more matured knowledge, gained for itself such general recognition at the hands of competent experts, that the great majority of them now deem it just as well grounded as any of the foregoing phylogenetic hypotheses.

In the face of such encouraging unanimity we can afford quietly to ignore the opposition which is still raised here and there by some single opponents of transformation. There is one capital fact in our favour, the whole of the younger generation is working in Darwin's spirit, and far beyond the limits of professional circles his doctrine is operating as a ferment, stimulating to nearer solution the greatest problems of human knowledge.

Celebrating here to-day the complete victory of Darwin's doctrine of development, as we are, accordingly, entitled to do,

---

[1] The influence of my earthly days
Will last through eons.

it is also implied that the end has come to the dreary period of violent literary warfare; and we may give all the more emphatic expression to our jubilant feeling of triumph in this respect, that we have ourselves been largely involved in those hard battles. Seeing, however, that according to Heraclites, struggle is the father of all things, it was not possible that the struggle for existence should spare the theory which itself laid down this principle and raised it to be the most valuable instrument in its store-house of arguments. With all the greater welcome we now greet the new period of peace following on that victory, and of quiet progress in which we look forward to the fairest fruits in the new courses of inquiry. It well becomes the Association of German Naturalists and Physicians who have repeatedly been witnesses of the loud tumult of those battles, now when they are happily concluded, to sanction the treaty of peace, and to solemnly recognise the doctrine of development as the sure foundation-stone of scientific inquiry.

If we now look for the causes of the extraordinary effect produced in such a short time by the Darwinian doctrines, in the teeth of the most violent opposition, we will find them by no means exclusively in the convincing force of their inherent truth, but also in the peculiarly favourable outward circumstances in which they entered the scientific world. Not the least of these favourable conditions lies in the rare characteristic qualities of the man on whom devolved the solution of such a gigantic task. Charles Darwin united in himself a wealth of diverse intellectual gifts which generally are to be found only apart. His fund of knowledge and his acumen as a naturalist were just as great as his far-sightedness and comprehensiveness as philosopher. To what degree he harmoniously combined these two sides of intellectual activity, often in conflict with each other, may be inferred from the fact that many short-sighted experimentalists see in him only the conscientious observer and ingenious experimentalist, regretting that his theory should be but speculative aberration; while on the other hand many high aspiring thinkers look down with great depreciation on his experimental achievements, but admire the acuteness of his judgment and the lucidity of his logical train of thought. In this respect he reminds us of our two greatest German naturalists, Johannes Müller and Carl Ernst Baer. If the latter in his title-page described his classical "History of the Development of Animals" as "Observation and Reflection," Darwin might say the same of all his works. With these rare powers of observation and judgment were associated other noble qualities of character greatly enhancing their value and profit; indefatigable perseverance in the pursuit of his aims, scrupulous conscientiousness in grouping the assured results, purest aspiration after natural truth, and open simplicity in communicating his conclusions. No less praiseworthy was the extraordinary modesty with which he set forth his views, and the mild meekness with which, while answering all the sharp objections of his opponents, so far as they were to the purpose, he simply ignored personal aspersions.

Truly admirable is the patience and forethought with which Darwin took in hand and carried out the weightiest task of his life—the explanation of the origin of animal and vegetable species through natural selection. The first basis to this work was laid in his twenty-third year, when in 1832, in South America, he drew up geographical and palæontological observations on the animal species of this continent. The rich observations he accumulated in that voyage round the world, a voyage lasting five years, and of such consequence to him, did not, however, come to their full utilisation till long afterwards. The injury to his health wrought by the severe hardships to which that voyage subjected him forced him to withdraw completely from the restless turmoil of London, and to reduce his circle of personal friends to the narrowest compass. In 1842, in the thirty-third year of his age, he betook himself to his quiet, idyllic country seat of Down, lying gracefully between the green meadows and the wooded hills of the sweet county of Kent.

In the harmonious solitude of this verdant seat of the Muses Darwin lived full forty years, devoting himself singly and exclusively to the continuous study of nature and to the solution of the great problem she had revealed to him. Practising, himself, for many years the active work of gardener and cattle-rearer, he could see under his own eyes the transformation of the corporeal forms of plants and animals. Examining into the physiological causes of these transformations, the laws, namely, of Inheritance and Adaptation, he clearly perceived that in the domain of uncultivated as well as of cultivated nature the same mechanical laws condition change of species. He became convinced that artificial and natural rearing rested essentially on the same processes of selection. What in the one case is produced in a short time by the purposively active will of man for his own advantage is in the other produced in a much longer time by the purposelessly active "Struggle for Existence" to the advantage of the transformed organisms.

But although Darwin had early conceived this fundamental thought of his "Theory of Selection," and throughout many years had collected the richest material of observations in its evidence, he could not for a long time resolve on the publication of his theory. It would ever appear to him too full of gaps, the mass of facts required for its support too defective, the chain of inferences too incomplete. He was ever wanting to accumulate fresh evidence, to bring ever more light from all sides on the questions in hand, and as far as possible to anticipate and refute objections to his conclusions. Perhaps in the end he would never have come to communicate the treasures of his knowledge to the world, had it not been for an outward impulse which constrained him to this step. At length then, in 1859, after the author had completed his fiftieth year, appeared his era-inaugurating chief work on the "Origin of Species," a work to which all the rest of his writings are but deductions and commentaries. This event happened just a full century after Caspar Friedrich Wolff in Germany had discovered the true development of the animal germ, and just half a century after Lamarck in France had prophetically propounded the principles established by Darwin.

The extraordinary modesty and unassumingness which Darwin showed to such a degree on the subject of the publication of the most important of his writings, displayed itself also on all hands in his extensive correspondence, and not less in his personal intercourse. Every one who had the happiness of making his personal acquaintance could not part from him without a feeling of the sincerest reverence and highest appreciation. Were it here allowed me to intercalate a few words on my personal meeting with Darwin, I would give expression especially to the high admiration of Darwin as an ideal man with which my three visits to him in Down inspired me. The first time was in October 1866, on the occasion of a voyage I was undertaking to the Canary Islands. I had just completed the "General Morphology," a work in which I had ventured on the experiment of mechanically establishing the science of organic forms on the basis of the theory of filiation as reformed by Darwin. By means of the proof-sheets I had sent him, Darwin was acquainted with my essay, and took all the more interest in it because these morphologic investigations lay rather remote from his own studies, which were principally experimental. It was, therefore, with the greatest pleasure that I responded to an invitation to come to Down, which he had sent me during my short stay in London.

In Darwin's own carriage, which he had thoughtfully sent for my convenience to the railway station, I drove one sunny morning in October through the graceful hilly landscape of Kent, that, with the chequered foliage of its woods, with its stretches of purple heath, yellow broom and evergreen oaks, was arrayed in the fairest autumnal dress. As the carriage drew up in front of Darwin's pleasant country-house clad in a vesture of ivy, and embowered in elms, there stepped out to meet me from the shady porch overgrown with creeping plants, the great naturalist himself, a tall and venerable figure with the broad shoulders of an atlas supporting a world of thoughts, his Jupiter-like forehead highly and broadly arched, as in the case of Goethe, and deeply furrowed by the plough of mental labour; his kindly mild eyes looking forth under the shadow of prominent brows; his amiable mouth surrounded by a copious silver-white beard. The cordial prepossessing expression of the whole face, the gentle, mild voice, the slow, deliberate utterance, the natural and *naïve* train of ideas which marked his conversation, captivated my whole heart in the first hour of our meeting, just as his great work had formerly, on my first reading it, taken my whole understanding by storm. I fancied a lofty world-sage out of Hellenic antiquity—a Socrates or Aristotle—stood alive before me.

Our conversation, of course, turned principally on the subject which lay nearest the hearts of us both—on the progress and prospects of the history of development. Those prospects at that time—sixteen years ago—were bad enough, for the highest authorities had for the most part set themselves against the new doctrines. With touching modesty Darwin said that his whole work was but a weak attempt to explain in a natural way the origin of animal and vegetable species, and that he should not live to see any noteworthy success following the experiment, the mountain of opposing prejudice being so high. He thought I had greatly over-estimated his small merit, and that the high praise I had bestowed on it in my "General Morphology" was far too exaggerated. We next came to speak of the numerous and violent attacks on his work, which were then in the ascendant. In the case of many of those pitiful botches, one was in fact quite at a loss whether more to lament the want of understanding and judgment they showed or to give the greater vent to the indignation one could not but feel at the arrogance and presumption of those miserable scriblers who pooh-poohed Darwin's ideas and bespattered his character. I had then, as on later occasions, repeatedly, expressed my just scorn of the contemptible clan. Darwin smiled at this, and endeavoured to calm me with the words, "My dear young friend, believe me, one must have compassion and forbearance with such poor creatures; the stream of truth they can only hold back for a passing instant, but never permanently stem."

In my later visits to Down in 1876 and 1879 I had the pleasure of being able to relate to Darwin the mighty progress which in the past intervals his doctrines had made in Germany. Their decisive outburst happened more rapidly and more completely here with us than in England, for the reason chiefly that the power of social and religious prejudice is not nearly so strong here as among our cousins across the Channel, who are better placed than ourselves. Darwin was perfectly well aware of all this; though his knowledge of our language and literature was defective, as he often complained, yet he had the highest appreciation of our intellectual treasures.

Darwin having in his great work of 1859, planting the basis of his doctrine, said nothing regarding its anthropological consequences, and having with wise reserve maintained silence on this subject down to the year 1871, it was for me of the highest interest, even as early as my first visit to him in 1866, to converse with him at large on that topic. As was to be expected, the great thinker felt not the slightest misgiving in recognising the necessary extension to man of the application of his doctrine of filiation. I had, therefore, the highest satisfaction in being able to set forth to him the first genealogical tables which I had then designed, and in all essential points to receive his approval. Though the special study of comparative anatomy and ontogeny, on which I based my phylogenetic plans, lay out of Darwin's province, he yet completely perceived their importance. In his celebrated work, in two volumes, on the "Descent of Man and Selection in relation to Sex" (1871), he has, therefore, declared himself to be in all principal points in harmony with me, and has expressly emphasised the importance in relation to the history of filiation of the numerous animal hereditary relics we possess in our human vertebrate organism.

If now we survey the huge mass of facts which in this and other works Darwin has gathered together with just as much forethought as boldness to serve as a support for his ideas—if we regard the innumerable observations and experiments he has himself instituted to establish their accuracy, we cannot but wonder at the strength of the giant-mind which has amassed such an abundance of knowledge and power, of experimental knowledge and philosophical science in the narrow compass of a single human life. Involuntarily we exclaim what a rare constellation of happy circumstances there must have been to render possible such extraordinary performance conjoined with commensurate success.

We must then, undoubtedly, admit that in the case of Darwin, merit and fortune went hand in hand, and that rare favour on the part of fate made it possible for him to execute completely his great life-task. Free from all the cares and worries of a week day existence, enjoying in security a comfortable home and a happy family life, undisturbed by professional business and official duties, he was able to devote himself throughout half a century exclusively to his favourite studies. While the solitude of his tranquil country-seat saved him from the turbulent traffic in knowledge which in large cities consumes the best powers of a man, it also supplied him with those conditions which were most favourable to the composure and harmony of his rich world of thoughts. In our opinion nothing is more prejudicial to scientific work of a deep and earnest character than the pedantic wrangling of our great universities and the partisanship of scientific colleges. From this as from all posts of honour and other such disturbing influences of the outside world Darwin his whole life long kept himself remote, and he acted wisely in so doing!

While, therefore, the great naturalist owed his unexampled success in the first place to himself and his noble endowment, some share in the credit must also be allowed to the favourable scientific situation of the time, which was furthersome in a high degree. Ever since the failure of the older nature-philosophy in the beginning of our century, since Goethe and Kant in Germany, Lamarck and Geoffroy in France, failed in their attempts to direct the minds of men to the natural development of the organic world, a strictly experimental method became the universal practice in the domain of biology. The task thus set before scientific labourers was that of the most exact investigation into all the particular forms and phenomena of animal and vegetable life; the monistic explanation of the whole, and, in particular, the solution of the problem of creation being abandoned. The foundation of embryonic history by Baer, of comparative anatomy and palæontology by Cuvier, the reform of physiology by Johannes Müller, the propounding of the theory of cells and of the doctrine of tissues by Schleiden and Schwann had opened up new and grand provinces to natural experiment, whence was drawn by numerous labourers inquisitive for knowledge an astounding abundance of facts. In the short space of half a century there arose quite a series of new sciences.

The more, however, that from year to year the number of new discoveries accumulated, the higher that the flood of literature swelled, the more confused became the chaos of the general theory of nature, and the greater was the necessity felt by thoughtful inquirers for an elevation above the stifling mass of detached observations to universal monistic points of view and to the knowledge of real causes. This requirement was now most happily met by the new doctrine of development. It is true that, as early as 1809, in the year of Darwin's birth, Lamarck had clearly demonstrated that the similarity of organic forms was to be explained by their common derivation and their diversity by their adaptation to the conditions of existence. He had, however, failed to attain a knowledge of the active causes which Darwin fifty years later disclosed in his theory of selection.

It is therefore in complete contradiction with the historical facts and a proof of utter ignorance of the history of biology, when even at the present day a few individual opponents of Darwinism declare the theory to be a vague hypothesis, in support of which evidence has yet to be adduced. In reality the very opposite is the case. The actual evidence for the common descent of the manifold forms of life had already long been adduced before it was formulated by Darwin into a clear scientific theory. Numerous physiological experiments even had long before been carried out in support of it. For the total results of our horticulture and animal rearing—and the mass of new forms of life which civilised man has artificially produced to his own profit and advantage are just so many experimental proofs of the theory of selection. And as concerns the "struggle for existence," the essential element in Darwinism, no particular arguments, in truth, are needed; for the whole history of mankind is nothing else!

Our whole science of living nature, which in one word we designate Biology, was, accordingly, perfectly prepared for the reception of the fertilising ideas of Darwin, and hence in large measure we explain their extraordinary success, in contrast with the pre-maturity and inefficacy of the similar theories of his predecessors. The high merits of these predecessors Darwin with his noble sense of justice has on all occasions recognised. It is, therefore, far from the spirit of the great master when in our day some over-zealous disciples of his (particularly in England) are intent on celebrating him as the sole founder of the new doctrine of development, as though it had all at once sprung ready-made from the head of the thinker, like Minerva armed from the forehead of Jupiter. On the contrary, we believe that we are acting perfectly in the spirit of our deceased master and friend if we here call to honourable remembrance his great predecessors. The splendour of his name can only be enhanced by showing that in the most important principles of his theory of nature he was in unison with a select number of the greatest minds the history of human civilisation can boast of.

We have to go back no less than twenty-five centuries, into the grey fore-time of classic antiquity, to come upon the first germs of a philosophy of nature, pursuing Darwin's goal with distinct consciousness; the demonstration, namely, of natural causes for the phenomena of nature, and thereby the eviction of faith in supernatural causality, of faith in miracles. The founders of the Greek philosophy of nature in the seventh and sixth century before Christ were the first who laid down this true foundation-stone of knowledge, and endeavoured to discover a natural common original basis of all things. This conscious aspiration after absolute causality, after the unifying knowledge of a common cosmic cause, appears all the more admirable that proper experimental investigation of nature was at that time quite out of the question.

Perhaps the most important among these Ionian natural philosophers was Anaximander. He assumes that out of infinity of matter through eternal revolution numerous world-bodies came into being as condensations of the air, and that the earth, too, as one of these world-bodies, issued out of a state originally fluid and afterwards aëriform. He consequently anticipated the fundamental conception, valid at this day, of the natural development of the world, which 2400 years subsequently, in 1755, our greatest German philosopher, Immanuel Kant, in his "Universal History of Nature and Theory of the Heavens," universally established. As here in the cosmological kingdom, Anaximander appears as forerunner of Kant and Laplace, so also at the same time in the biological kingdom he prophetically prefigures Lamarck and Darwin. For according to him the earliest living creatures on this globe originated in water through the operation of the sun. From these creatures, later on, were developed the land-inhabiting plants and animals which left the water and adapted themselves to life on dry land. Man, likewise, has gradually worked himself up from animal organisms, and, in reality, from fish-like aquatic animals.

If here to our surprise we find clearly enunciated some of the most important fundamental conceptions of our current theory of development, we recognise it still more distinctly in its integrity one hundred years later in Heraclites of Ephesus. He it was who first propounded the principle that a great uninterrupted process of development prevades the whole universal world, that all forms are involved in an everlasting current, and that struggle is "the father of all things." Seeing that nowhere in the world exists absolute rest, and that all standing—still is but apparent, we are compelled everywhere to assume a perpetual change of matter, a constant variation of form. That is only possible, however, through the fact that one form thrusts out the other, and that the new violently usurps the place of the old; or, in other words, through the universal "struggle for existence."

This principle of nature set forth by Heraclites that everlasting movement or the struggle among all things is the fundamental agent of the world received a much deeper interpretation a little later in Empedocles of Agrigent in Sicily. He, too, assumes an uninterrupted change of phenomena, but finds the universal fundamental cause of the everlasting universal struggle in the two counteracting principles of hate and love, or, as our modern physics expresses it, of the attraction and repulsion of parts. As the mixture of bodies is effected by love so is their separation by hate. If in the present day we regard the attraction and repulsion of atoms as the ultimate ground of all phenomena we find, then, this fundamental proposition of our modern doctrine of atoms already anticipated in Empedocles. It is however still more remarkable that Empedocles makes the purposive forms of organisms come into existence through the accidental conjunction of counteracting forces. Out of this great struggle the living forms now existing have issued victoriously because they were best prepared for the battle, and therefore most capable of life. Here we have not only the fundamental conception of Darwin's theory of selection forestalled, but also the solution of the great riddle indicated, "How can organic forms constituted for a particular purpose come into existence in a purely mechanical way without the co-operation of a final cause acting with a particular purpose?"—the same riddle the solution of which we account to be Darwin's highest philosophical merit.

Among all the great philosophers of classical antiquity, the three we have already named, Anaximander, Heraclites, and Empedocles, are undoubtedly those who have most clearly enunciated the most important elements of the monistic theory of nature now prevalent. But besides these we find other contemporaries of theirs who held similar conceptions of development, such as Thales, Anaximenes, Democritus, Aristotle, Lucretius, &c. Yet were these various attempts at a genetic theory of nature soon thrust into the background by an opposing scheme of the world, that, namely, of the "Philosophy of Ideas," which was propounded by the sophists, and had its centre in Plato.

If these fresh-minded experimentalists of Ionian philosophy sought to explain the totality of the world by natural causes through mechanical processes, the Platonic school set up, in opposition to this view, supernatural causes, in the form of teleological ideas. There thus arose a mode of thought and inquiry which, withdrawing the mind from the objective knowledge of nature, placed the subjective being of man in the forefront of our contemplations, a mode which throughout a space of more than 2000 years exercised its baleful influence in ever increasing measure. In complete contradistinction to the "Unity of Nature," everywhere demonstrated by the causality of her phenomena, there developed mightily the dualism invented by Plato, a harsh antithesis between God and world, between idea and matter, between force and stuff, between soul and body. The numerous forms of organic nature which we distinguish as animal and vegetable species no longer appear as different stages in the development of common original forms, but as embodiments of so many innate, eternal and unchangeable "ideas," as "constant species"—or, as Agassiz, Darwin's greatest opponent, expressed it, "embodied creative thoughts of God."

This Platonism found its strongest support in the dogmas of Christianity which preaching retirement from nature came into friendly agreement with the "philosophy of ideas." The accelerating decline, again of the sciences which followed the tragic destruction of noble Hellenism operated in favour of both Platonism and Christianity. Throughout the whole long spiritual night of the Christian Middle ages there was no inward impulse to a monistic theory of nature on the ground of experimental investigation. In truth, however, there were not wanting attempts in this direction on the ground of pure speculation. In particular, the Pantheistic systems of Giordano Bruno and of Benedict Spinoza in the sixteenth and seventeenth centuries are admirable essays towards a monistic and natural comprehension of nature. These Pantheistic cosmologies, however, which in all material things assume an impelling world-soul in inseparable unity, were yet especially directed on the province of ethics or practical philosophy, and lacked, alas too desperately, all experimental foundation through immediate observation of nature—for in truth there was then no such thing. The whole sense and tendency of most thinkers of that time were turned away from Nature and bent exclusively on man, who was considered to hold a position beyond and above Nature. Even those monistic systems, therefore, of Bruno and Spinoza had no power to establish themselves in the face of the all-mighty dualism which, through Platonism and Christianity, attained to universal supremacy.

Not till a long period afterwards, not till the middle of the last century, did the natural reaction against that dualistic scheme of the world finally assert itself. Then at length did man begin to turn to the true source of all knowledge, to nature herself. Especially in regard to the knowledge of animate bodies in nature, knowledge which had hitherto for two thousand years been drawn almost exclusively from the well of Aristotle, a new era of independent observation sprang up. The outward form and inward structure of plants and animals, their vital phenomena, and their development were now for the first time the subject of zealous and extensive investigation on the part of numerous naturalists. The plenitude of interesting facts which this source of natural revelation supplied could not, however, but again excite inquiry after the efficient causes, and soon the idea of natural development as an answer to the question forced its way out again.

The so-called school of the "older philosophy of nature," towards the end of the last and the beginning of the present century, first appears, simultaneously in Germany and France, as the new banner-bearer of this idea. But independently of this school, we see a number of the greatest thinkers and poets of our classical literary period moved by the same idea, above all Goethe, Lessing, Herder, Kant; later, Schelling, Oken, and Treviranus. In France, again, we notice Lamarck, Geoffroy St. Hilaire, and Blainville; in England Erasmus Darwin, the grandfather of our reformer who, in accordance with the laws of latent heredity, transmitted a whole series of characteristic intellectual qualities to his grandson. Time does not allow us to-day to follow with a view towards comparison of the different expressions of the conception of development in these eminent thinkers, and, besides, much in this respect is already universally known. We will on this occasion confine our attention to two of the most eminent minds, to Goethe and Lamarck—as in our opinion, of all Darwin's predecessors, they are the most important.

The significance of Goethe as naturalist has in our time been so often and so searchingly treated by several of our most esteemed biologists, that we may assume the most of it also to be common property. We will therefore on this occasion expound only that point which for us to-day is of quite peculiar interest, and has at the same time been very variously conceived, the question, namely, how far the general theory of nature held by our greatest poet agrees with Darwin's. In 1866 in my "General Morphology" I placed Goethe and Lamarck side by side with Darwin as the most important of the founders of the theory of filiation, and in the way of evidence had compiled from their writings a great number of specially remarkable passages. Their number has lately been increased by others. In the case, however, of a universal genius like Goethe, the question depends far less on the number and form of particular passages in which he communicates his view of the "formation and transformation of organic natures" as on the whole spirit of his grand and thoroughly monistic theory of nature, and on this subject those who have a general knowledge and comprehension of Goethe cannot now entertain any doubt. In that valuable legacy entitled "God and the World" he has left us in superabundance a collection of confessions as perfectly beautiful in their form as they are significant in their substance.

The preface to these confessions, the Proem, at once expresses the fundamental monistic thought of Goethe's general view of nature, the inseparable unity of Nature and God, in a manner which leaves us in no doubt:—

> "Was wär' ein Gott, der nur von aussen stiesse,
> Im Kreis das All am Finger laufen liesse!
> Ihm ziemt's, die Welt im Innern zu bewegen,
> Natur in Sich, Sich in Natur zu hegen,
> So dass was in Ihm lebt und webt und ist,
> Nie Seine Kraft, nie Seinen Geist vermisst!"[1]

Consider, in addition, the following wonderful poems: "The World-Soul," "One and All," "Legacy," "Parabase," "Epirrhema," &c.; consider, moreover, his pronounced confession to Spinoza's doctrine, and we cannot really find any essential divergence from our current monistic comprehension of the world as newly established by Darwin. And what a high value Goethe himself attaches to it is seen in his question:—

> "Was kann der Mensch in Leben mehr gewinnen
> Als dass sich Gott-Natur ihm offenbare,
> Wie sie das Feste lässt zu Geist verrinnen,
> Wie sie das Geisterzeugte fest bewahre?"[2]

That, accordingly, our great Prince of Poets considered the world only as a monistic process of development in the sense of the Hellenic philosophy of nature, is further demonstrated, among other passages, by the dialogue between Thales and Anaxagoras in the Classical Walpurgis-Night. We would also point out the emphasis with which in geology he held fast to the theory of a gradual and uninterrupted development of our planet and its mountains. From the very beginning he was the most decided opponent of the fallacy of repeated violent revolutions in our globe, a fallacy which developed itself in the beginning of our century, and through Cuvier, in particular, came to be generally accepted. "The violence and leaps in this doctrine," he said, "I cannot away with, for they are not in accordance with nature. Be the matter as it will, it must stand written, that I curse this confounded hurly-burly apparatus of the new creation of the world. And, assuredly, a talented young man will yet arise with the courage to oppose this universal craze!" Only a few years passed till this expectation was fulfilled. For in 1830 appeared Darwin's like-minded countryman, the great geologist, Charles Lyell, and delivered his continuity-theory, the doctrine which is now universally received, of the gradual and uninterrupted development of the earth from natural causes, a mechanical geological theory which, perfectly in Goethe's sense, excluded all violent revolutions of the earth from supernatural causes.

If here in the province of geology Goethe shows himself as a most decided adherent to a monistic theory of development, we find him much more so in the province of biology. For the knowledge of the living substance, this "precious, glorious thing" was truly his peculiar pet-study. Here, especially in Morphology, his "Doctrine of Forms," he has cast glances into the inner origin and birth of organic forms, glances deep and clear such as were possible only to a genius who was simultaneously thinker and artist, naturalist and philosopher.

Among the many interesting contributions Goethe has made to morphology, the most valuable and most elaborate is the "Metamorphosis of Plants," which appeared in 1790. In this mature product of his botanical studies, which lasted throughout many years, and which most seriously engaged him during his travels in Italy, he deduces, as is well known, the whole endless wealth of forms in the vegetable world from one single protoplant, and makes all its different organs come into being through manifold transformation and process of development on the part of one single fundamental organ, the leaf. With this work occurred, in point of fact, the first attempt to refer the endless multiplicity of individual vegetable forms to one common original type.

> "Alle Gestalten sind ähnlich, doch keine gleichet der andern;
> Und so deutet das Chor auf ein geheimes Gesetz.[1]

This "secret law," this "sacred riddle," is the common descent of all plants from that protoplant, conjoined with the fact that the special differences are effected by the different circumstances and conditions of their existence.

As in the "Metamorphosis of Plants," so also in the "Metamorphosis of Animals," Goethe seeks, likewise, after the common prototype out of which all the allied forms have been produced through diverging development.

> "Alle Glieder bilden sich aus nach ew'gen Gesetzen,
> Und die seltenste Form bewahrt im Geheimen das Urbild.
> Also bestimmt die Gestalt die Lebensweise des Thieres,
> Und die Weise zu leben, sie wirkt auf alle Gestalten
> Mächtig zuruck. So zeiget sich fest die geordnete Bildung
> Welche zum Wechsel sich neigt durch äusserlich wirkende Wesen."[2]

As is clearly seen in numerous other passages of his morphological studies on "Formation and Transformation of Organic Natures," that "primal form" or "type" was the inward original community which lies at the basis of all organic forms and the original formation-tendency which is transmitted by inheritance. On the other hand, the "unrestrainable progressive transformation which arises from the necessary conditions and relations of the external world," is nothing else than *Adaptation* to outward conditions of existence. This latter is the centrifugal formative-energy of "Metamorphosis"; the former, again, is the centripetal formative-energy of "Specification." The clear knowledge of these two formative-energies, counteracting and balancing each other, was so highly prized by the poet that he enthusiastically extols it as the "highest thought to which creative nature soared."

The province in animal morphology to which Goethe applied himself with peculiar predilection was comparative osteology, the skeleton-theory of vertebrates. The reason for this is to be found in the fact that nowhere perhaps to such a degree as here does the operation of that highest nature-conception of manifold development out of one single typical fundamental form meet us with such all convincing force. Down to the present day, consequently, the comparative skeleton-doctrine has remained the special favourite of morphologists. While in this province Goethe demonstrated the unity of the vertebral formation in the different divisions of vertebrates, and while in his celebrated skull-theory he further showed that the skull was composed of a series of transformed vertebræ, he arrived in 1795 at the following remarkable utterance: "So much then have we attained as to be able to assert without any misgiving that all the more perfect organic natures—under which we imply fishes, amphibious animals, birds and *mammals with man at their head*—have all been formed after one original image, which in its highly persistent parts only deviates more or less here and there, and yet daily by propagation transforms and perfects itself."

Some of our opponents have raised the objection that these and similar passages of Goethe are no "scientific truths," but only poetical or rhetorical flourishes and images; the type he meant was only an "ideal pro-type," no real genealogical form. It appears to us that this objection betrays little understanding of the greatest German genius. He who is acquainted with Goethe's thoroughly objective mode of thought, who appreciates his thoroughly living and realistic view of nature, will, with us, entertain no doubt that under that "type" was intended a perfectly real descent of kindred organisms from a common genealogical form. That the great understander of man did not thereby exclude man

---

[1] What kind of God were He who impelled things only from outside, and let the universe twirl round His finger! It seems proper to Him to move the world inwardly, to cherish nature in Himself, Himself in Nature, so that whatever lives and works and exists in Him never misses His power nor His spirit!

[2] What greater gain in life can man achieve than the revelation of God-Nature to him, the evolution of spirit from substance and the substantiation of spirit?

[1] All forms are similar, yet no one exactly the same as the other; and so the chorus points to a secret law.

[2] All members work themselves up according to everlasting laws, and the rarest form preserves in secret the primitive type. The form, therefore, determines the animal's mode of life, while, reciprocally, the mode of life reacts powerfully on all form. Thus the regulated structure firmly maintains to itself whilst yielding to change through the action of outward substances.

from the development series of the other vertebrates is indicated with special clearness in his comparison of the human skull with that of lower mammals. He here expressly points out several places in the human skull as remains of the animal skull "which are found in stronger proportions in such a low organisation, but have not quite disappeared in man, in spite of his elevation."

No less does his celebrated discovery of the intra-maxillary bone testify to the same conviction. Man, like the other mammals, having cutting teeth must also, Goethe concluded, possess the intra-maxillary bone which showed itself in the other mammals; and in point of fact after the most careful anatomical investigations he established his point, although it had been disputed by the highest anatomical authorities.

Highly remarkable, moreover, in this respect is the agreement Goethe expresses with the kindred view of Kant in his "Critique of the Faculty of Judgment," a work the "great main thoughts of which were entirely analogous with his own work, action, and thought hitherto." The great Königsberg philosopher had enunciated the descent of all organic beings from a common original mother (from man down to polyp) as a hypothesis which "alone was in harmony with the principle of the *Mechanism of Nature, without which a Science of Nature was altogether impossible.*" This theory of descent, however, he had at the same time called "a daring adventure of reason." In reference to this passage Goethe remarks: "Had I first unconsciously and in obedience to inward impulse restlessly pressed forward in the direction of that Original Form, that Type—had I even succeeded in building up a scheme conformable with Nature; now at length could nothing hinder me from *boldly maintaining* the *Adventure of Reason*, as the sire of Königsberg calls it."

Finally, nothing can more strongly show the extraordinary interest with which Goethe followed this transformation-theory, down to the end of his life, than the well-known attention he gave to the dispute between Geoffroy St. Hilaire and Cuvier. "This event is for me of altogether incredible importance," exclaims the grey-headed old man of eighty-one years, with youthful fire, "and I have a right to jubilate over the universal victory, at last witnessed, of a cause *to which I have devoted my whole life*, and which, too, is mine in a quite especial manner." The vivid representations of this most significant dispute, completed by Goethe in March, 1832, just a few days before his death, is the last literary legacy the greatest poet and thinker of the German nation has left behind him; and to this great intellectual contention also his last word applies, "more light."

It is deeply to be regretted that the "Philosophie Zoologique," by Lamarck, a work of the highest moment which appeared in 1809, was wholly unknown to Goethe. For just in the development theory of this work, which is quite differently arranged and strictly systematically composed, he would have found much that was wanting to himself, much that would have yielded him the most complete supplement for his own incomplete studies. In reference as much to the monistic and complete elaboration of the development theory as to the many-sided experimental establishment of it on fact, the great work of Jean Lamarck is much more important than the similar essays of all his contemporaries, more particularly of the like-named work of Geoffroy St. Hilaire. When one considers with what extraordinary interest Goethe took up the latter work, it may be concluded that he would have given a much warmer reception still to the rich-thoughted work of Lamarck.

We cannot but regard it as a truly tragic fact, that the "Philosophie Zoologique" by Lamarck, one of the greatest productions of the great literary period in the beginning of our century, met, from its outset, with but extremely little attention, and in the course of a few years was utterly forgotten. Not till Darwin fifty years later on breathed new life into the Transformation theory therein established, was the buried treasure again brought into the light of day, and we cannot now but describe it as the completest representation of the theory of development prior to the time of Darwin. Nay, it seems to us the necessary atonement of a great historical injustice, if again to day (as was done sixteen years ago in the "General Morphology"), we place the great Frenchman side by side with the greater Briton and the greatest German. Each of the three great middle—European nations of culture has in the course of a century presented mankind with an intellectual giant of the first rank, who grasped in its entire significance the fundamental conception of the monistic development of the world from natural causes.

It would carry us much too far were we here to attempt setting forth an abstract of Lamarck's work and comparing it with Darwin's. It will suffice to cite some of the weightiest fundamental conceptions which characterise his theory of nature, and indicate how far he was in advance of his time. For many decades the great French biologist had occupied himself very searchingly with systematic botany and zoology. Testimony of this we have in his two celebrated and much used special works, the "Flore française," and the "Histoire naturelle des animaux sans vertèbres." While he was engaged in substantially classifying and describing not merely the forms already in existence, but also their extinct ancestors which he incorporated into his system, there was disclosed to him the inner morphologic connection between the former and the latter, and from this disclosure he inferred their common descent. All animal and vegetable forms which we distinguish as species, possess, accordingly, but a relative temporary persistence, and the varieties are the beginnings of species. The form-group of the species is, therefore, just as artificial a product of our analytic understanding as is the genus, the order, the class, and every other category of the system. The change in the conditions of life, on one hand, the employment or non-employment of the organs, on the other, exercise a constantly transforming influence on the organisms; they effect by means of adaptation a gradual transformation of forms, the fundamental lineaments of which are through inheritance transmitted from generation to generation. The whole system of animals and plants is in reality, therefore, their genealogical tree, and portrays to us the relations of their blood-kindredship. The course of development of life on our globe was, accordingly, continuous and uninterrupted, just as was the course of development of the earth itself.

While Lamarck thus clearly enunciates all the essential fundamental conceptions of our current doctrine of filiation, and by the depth of his morphological knowledge excites our admiration, the clear advanced outlooks he takes in his conceptions of physiology are no less surprising. While in his time the fallacy of a supernatural vital force was yet universally prevalent, Lamarck rejected that idea, and maintained that life was only a very complicated physical phenomenon. For all vital phenomena are based on mechanical processes which are themselves conditioned by the constitution of organic matter. The phenomena of soul-life (*Seelenlebens*) are also, in this respect, not different from other vital phenomena. For the ideas and activities of the understanding are based on motional processes in the central nerve-system; the will in truth is never free, and reason is only a higher degree of development and combination of the elements.

In these and other propositions Lamarck raises himself far above the general theory of nature held by most of his contemporaries, and sketches a programme of future biology which only in our days has come to be carried out. In view of the great clearness and consistency of his system it is only a matter of course that he should assign to man his natural place at the head of the vertebrates, and explain the causes of his transformation out of ape-like mammals. With equal acumen, however, he handles one of the darkest and most difficult questions of the whole theory of development, the question regarding the origin of the first living beings on our globe. For the answering of this question he assumes that the common earliest genealogical forms of all organisms were absolutely simple beings, and that they came into existence immediately out of inorganic matter in water by *Spontaneous generation*, through the combined effect of different physical causes. Such simplest organisms, however, were at that time not yet at all discovered; not till half a century afterwards were they actually come upon in the Monera.

Lamarck reached the great age of eighty-five years; consequently he lived two years longer than Goethe, and twelve years longer than Darwin. But while the two latter enjoyed the happiness of beholding the long beautiful evening of their life glorified by a sun-like splendour of success and worldly fame, poor Lamarck closed his long and laborious life misunderstood, solitary and needy. Ten years before his death he suffered the misfortune of blindness, and could only from memory dictate the last part of his great natural history of invertebrate animals to his two daughters who tenderly nursed him, and whom he left behind him without any means of support. Let us hope that the bitterness of his hard fate was qualified by the consciousness of his having cast the deepest glances into the mysteries of creative nature, and that the clear intellectual eye of the blind prophet often descried the laurel garland which thankful posterity would one day lay on his lonely grave.

Unquestionably the greatest defect in Lamarck's work was the insufficiency of the stock of observations and experiments he brought forward in proof of his far-reaching principles. For then, as now, the great majority of naturalists want, above everything, to have palpable facts in the hand. Then as now we find the paradoxical phenomenon, that the great majority of people accept without any misgiving and trample under foot the most absurd hypotheses and dogmas, while on the other hand they encounter well-founded scientific theories with the more suspicion and opposition the more they approach the truth. Among the experimental proofs of theories, moreover, to most people those are not the most welcome which are furnished by a continuous series of phenomena and a whole large class of facts. What they most desire is the particular observation, the single experiment. A large part of Darwin's immense success is due to the fact that he brought into the field to a truly overwhelming amount exactly such particular pertinent observations and experiments. Poor Lamarck on the contrary, trusting to the logical conclusion-drawing faculty of naturalists, for the most part neglected the business of palpable particulars.

The comparison of these three great natural philosophers in whom the foundation-laying development theory of our current natural science was most powerfully and comprehensively revealed is of high interest, for all three are very different among themselves both in respect of their general genius and the fortunes of their life outwardly and inwardly, as also, very especially, in respect of their courses of study and the ways by which they pursued their high aims. Lamarck starts from the most careful special studies of individual animal and vegetable forms, and by his many years' systematic examination and comparison of them is brought to the conviction that all living and fossil species have developed themselves out of a few simple common geneological forms. Goethe arrives at the same conclusion on the ground of his general studies in comparative morphology, directed by the conviction that the unity of the common type or the hereditary protoform can be traced out, everywhere in all the different organic forms, however manifoldly they may be transformed in individuals through adaptation to outward circumstances. Darwin, finally, first answers to his own satisfaction the question by what causes the new culture-forms of animals and plants reared by men come into being, and then demonstrates that the struggle for existence is the same cause which in like manner by the inter-action of adaptation and inheritance constantly produces new organic species in the free state of nature.

In these wholly different ways and by application of wholly different methods of investigation, all these three naturalists arrive ultimately at the same conclusion—to the acceptance, namely, of a monistic and continuous development of the whole of organic nature, through the operation alone of natural causes, to the exclusion of all supernatural creative miracles. All three, however, being at the same time deep-thinking philosophers and keeping constantly in their eye the unity of the whole world of phenomena, their idea of development expands to a grand pantheistic conception of the world, to that doctrine of oneness which forms the essence of our current monistic theory of nature.

The immeasurable effect which the decided triumph of this monistic view of nature already in this day exercises on all provinces of human knowledge, an effect increasing in geometrical progression from year to year, opens to us the happiest prospect regarding the further intellectual and moral development of mankind. I repeat here my firm personal conviction that in future this progress of scientific knowledge will be esteemed the greatest turning-point in the intellectual history of man.

We would in a quite especial manner emphasise this reconciling and compensating influence of our genetic theory of nature, all the more that our opponents are constantly endeavouring to obtrude disruptive and decomposing tendencies on it. These destructive tendencies are said to be directed not merely against science, but against religion and so against the most important foundations, in general, of our civilised life. Such grievous charges, so far as they really rest on conviction and not merely on sophistic fallacies, can be explained only by the fact of a mischievous misunderstanding of what forms the genuine kernel of true religion. This kernel does not consist in the special form of one's confession of faith, but rather in the critical conviction of an unknowable, common, ultimate ground of all things and in practical ethics springing immediately from the purified theory of nature.

In this confession, that with the present organisation of our brain the last ultimate ground of all phenomena is unknowable, the critical philosophy of nature comes athwart dogmatic religion. This faith in God, however, of course, assumes, endlessly different forms of confession according to the endlessly different degrees of the knowledge of nature. The further advances we make in the latter—the more we approach that unattainable ultimate ground—the purer will be our idea of God.

The purified knowledge of the world in the present day knows that natural revelation alone which in the book of nature lies open to every one and which every unprejudiced man with sound senses and sound reason can learn out of it. From this is derived that purest monistic form of faith which attains its climax in the conviction of the *unity of God and Nature* and which has long ago found its most complete expression in the confessions of our greatest poets and thinkers, Goethe and Lessing at their head. That Charles Darwin, too, was penetrated by this religion of nature, and did not acknowledge a particular church-confession is patent to every man who knows his works. . . .

Only in law-regulated society can man acquire the true and full culture of the higher human life. That, however, is only possible when the natural instinct of self-preservation, Egoism, is restricted and corrected by consideration for society, by Altruism. The higher man raises himself on the ladder of culture, the greater are the sacrifices which he must make to society, for the interests of the latter shape themselves evermore to the advantage of the individual at the same time; just as, reversely, the regulated community thrives the better the more the wants of its members are satisfied. It is therefore quite a simple necessity which elevates a sound equilibrium between Egoism and Altruism into the first requirement of natural ethics.

The greatest enemies of mankind have ever been, down to the present day, ignorance and superstition; their greatest benefactors, on the other hand, the lofty intellectual heroes who with the sword of their free spirit have valiantly contended with those enemies. Among these venerable intellectual warriors stand at the head, Darwin, Goethe, and Lamarck, in a line with Newton, Keppler, and Copernicus. These great thinkers of nature by devoting their rich intellectual gifts, in the teeth of all opposition, to the discovery of the most sublime natural truths, have become true saviours of needy mankind, and possess a far higher degree of Christian love than the Scribes and Pharisees who are always bearing this phrase in their mouth and the opposite in their heart.

How little, on the other hand, blind belief in miracles and the domination of orthodoxy is in a position to manifest true philanthropy is sufficiently testified not only by the whole history of the middle ages but also by the intolerant and fanatic procedure of the militant church in our days. Or must we not look with deep shame on those orthodox Christians who, in our day, again express their Christian love by the persecution of those of other faith and by blind hatred of race? And here in Eisenach, the sacred place where Martin Luther delivered us from the gloomy ban of adherence to the letter, did not a troop of so-called Lutherans venture some years ago to try anew to bend science under that yoke?

Against this presumption on the part of a tyrannical and selfish priesthood it will to-day be permitted us to protest on the same spot where 360 years ago the great Reformer of the church kindled the light of free inquiry. As true *Protestants* we shall rise up against every attempt to force independent reason again under the yoke of superstition, no matter whether the attempt be made by a church sect or a pathologic spiritism.

Happily we are entitled to regard these mediæval relapses as but transitory aberrations which will have no abiding effect. The immeasurable practical importance of the natural sciences for our modern culture-life is now so generally recognised that no section of it can any longer dispense with it. No power in the world is able again to roll backwards the immense progress to which we owe our railways and steamers, telegraphy and photography, and the thousand indispensable discoveries of physics and chemistry.

Just as little, too, will any power in the world succeed in destroying the theoretic achievements which are inseparably bound up with those practical successes of modern science. Among those theories we must assign the first place to the development doctrine of Lamarck, Goethe, and Darwin. For by it alone are we authorised firmly to establish that comprehensive *oneness of our theory of Nature* in which every phenomenon appears as but efflux of one and the same all comprehensive law of nature. The great law of the conservation of force thereby finds its universal application, embracing also those biological provinces which hitherto appeared closed to it.

In face of the surprising velocity with which in these last years the development theory has paved an entrance into the most diverse departments of inquiry we may here express the hope that its high pedagogic value also will be even more recognised, and that it will quite perfect the education of the coming generations. When five years ago, at the fiftieth Meeting of Naturalists in Munich, I laid stress on the high significance of the development theory in relation to education, my remarks were so misunderstood that a few words of explanation may here be allowed me. It stands to reason that with these words I could not mean to claim that Darwinism should be taught in elementary schools. That is simply impossible. For just like the higher mathematics and physics, or the history of philosophy, Darwinism demands a mass of previous knowledge which can be acquired only in the higher stages of learning. Assuredly, however, we may demand that all subjects of education be treated according to the *genetic method*, and that the fundamental idea of the development-theory, the *Causality of Phenomena*, find everywhere its acknowledgment. We are firmly persuaded that by this means, thinking and judging conformably with nature will be promoted in far greater measure than by any other method.

At the same time through this extended application of the development-doctrine, one of the greatest evils of our day in the culture of youth will be removed—the cramming of the memory, we mean, with dead lumber, which smothers the best powers and prevents both soul and body from coming to a normal development. This excessive cramming is based on the old fundamental ineradicable error that the *quantity* of *factual knowledge* is the best measure of culture, while, in truth, culture depends on the *quality* of causative *science*. We would therefore deem it especially useful that the selection of the material of instruction be much more carefully made, and that in making the selection, those departments which cram the memory with masses of dead facts do not receive the preference, but those which cultivate the judgment through the living stream of the development idea. Let our worried school youth only learn half as much, but let them understand this half more thoroughly, and the next generation will in soul and body be doubly as sound as the present.

In the most gladdening manner these requirements are being met by the reforms which are simultaneously in process of accomplishment in the most diverse provinces of science. Everywhere is stirring and moving fresh young life, stimulated by the idea of natural development—in the Comparative Study of Languages and in the History of Culture, as also in Psychology and Philosophy; in Ethnography and Anthropology no less than in botany and zoology. Everywhere the most joyful blossoms are bursting forth from the most varied branches of science, and its fruits will concurrently testify that they all spring from one single tree of knowledge and draw their nourishment from one single root. Thanks and honour, however, to the great masters who by their genetic and monistic theory of nature have led us to this clear height of knowledge from which with Goethe we may say:

> "Dieser schöne Begriff von Macht und Schranken, von Willkür
> Und Gesetz, von Freiheit und Mass, von heweglicher Ordnung
> Vorzug und Mangel, erfreue dich hoch; die heilige Muse
> Bringt harmonisch ihn dir, mit sanftem Zwange belehrend.
> Keinen höhern Begriff erringt der sittliche Denker,
> Keinen der thätige Mann, der dichtende Künstler; der Herrscher,
> Der verdient es zu sein, erfreut nur durch ihn sich der Krone.
> Freue dich höchstes Geschöpf der Natur, du fühlest dich fähig,
> Ihr den höchsten Gedanken, zu dem sie schaffend sich aufschwang
> Nachzudenken. Hier stehe nun still und wende die Blicke
> Ruckwärts, prüfe, vergleiche und nimm vom Munde der Muse,
> Dass du schauest, nicht schwärmst, die liebliche volle Gewissheit."[1]

OUR ASTRONOMICAL COLUMN

THE BINARY STAR 70 OPHIUCHI.—This star has received even more than a fair share of attention at the hands both of observers and computers, but there remain notwithstanding large outstanding differences between observation and calculation. As regards the orbit a very complete discussion of all the reliable measures to 1868, was made by Dr. Schur of Strasburg, while with eight years later measures, the elements were rigorously investigated by M. Tisserand in a memoir published by the Academy of Sciences of Toulouse. If Dr. Doberck in the course of his skilful and elaborate researches on the motion of the binaries has given attention to this star, his results have escaped our notice, but we subjoin the orbits deduced by Dr. Schur and M. Tisserand :—

	Schur.	Tisserand.
Periastron passage ...	1808·791	1809·664
Node	125° 22′	127° 22′
Node to periastron ...	155° 44′	149° 44′
Inclination	57° 56′	60° 0′
Excentricity	0·49149	0·47287
Semi-axis major	4″·704	4″·770
Period of revolution ...	94·370 years ...	... 94·929 years.

In 1879 the star was measured by Prof. Asaph Hall on five nights with the 26-inch refractor at Washington, generally under a magnifying power of 600; his epoch is—

1879·588 ... Position, 71°·32 ... Distance, 2″·930

Comparing with Schur's elements we find—

$$dP\,(c-o) = +\,5^{\circ}{\cdot}61 \quad \ldots \quad \ldots \quad dD = +\,0''{\cdot}726$$

While the errors of Tisserand's orbit are—

$$dP = +\,3^{\circ}{\cdot}01 \quad \ldots \quad \ldots \quad \ldots \quad dD = +\,0''{\cdot}497$$

The question naturally arises, how is it that after the most careful and complete determination of the orbit, it happens that in so short a time after the date of the latest measures employed in the calculations, the star appears to *bolt*, so to say, from its predicted course.

There have been suspicions from time to time that perturbation is indicated by the apparently anomalous differences between observation and computation. Mädler, discussing the elements of the orbit in 1842, when truly he had but a very limited and comparatively imperfect series of measures at his command to what we can now utilise, went so far as to doubt the efficiency of the theory of gravitation to explain the motion of the components of this double star, or at least he considered the question reduced to one of two alternatives, which he thus presents :—

(1) "The motion in this binary system does not follow the Newtonian law."

Or (2) "The middle point of the images which the stars form to us is not the centre of gravity of the masses."

And he recommended the star to close scrutiny with the most powerful instruments, with the view to ascertain whether there were any visible disturbing body.

The existence of a third star was suggested by Jacob, to explain similar anomalies which he believed to have been indicated by the measures, but Mr. Burnham, in 1878, examined 70 Ophiuchi with the 18½-inch Alvan Clarke refractor at Chicago with only negative evidence: "Both stars were perfectly round, with the highest powers on this occasion, . . . and no trace of any third star near." Such had also been his previous experience.

It thus becomes all the the more desirable to ascertain how far the suspected deviations from unperturbed motion may exist in the observations themselves, and more attention might perhaps be given with advantage to the investigation of personal equation between the various observers, the elimination of the effect of obliquity of direction of the components, or other cause which could possibly affect the comparison of the separate results. The evidence that such influences exist is pretty evident in the case of this particular star. For instance if we compare the above orbits with an epoch, only one year later than that of Prof. Hall, viz., Jedrzejewicz's for 1880·656, giving the position 62°·82, distance 2″·75, we get the following differences between calculation and observation :—

In Schur's orbit ... ... $dP = +\,10^{\circ}{\cdot}81$ ... $dD = +\,0''{\cdot}72$
In Tisserand's orbit ... $dP = +\;\;7^{\circ}{\cdot}88$ ... $dD = +\,0''{\cdot}51$

Exhibiting an increase of errors in the course of a year which cannot be wholly attributed to errors of elements depending upon a long course of measures.

Another circumstance connected with 70 Ophiuchi, which is attended with some difficulty of explanation, may be mentioned here. Prof. Hall, in addition to measuring the principal com-

---

[1] This fair idea of might and limit, of will and law, of freedom and measure, of order in movement, of excellence and defect, gladden thee deeply; the holy Muse brings it harmoniously to thee, instructing thee with generous constraint. No higher idea achieves the moral thinker, no higher the active man, the creative artist; the regent worthy to rule finds happiness in his crown through this idea alone. Rejoice, oh highest creature of Nature, that thou feelest thyself able to think after Nature the highest thought to which the creatively soared. Here now stand still, and turn thy looks backwards, examine, compare, and hear the words of the Muse, that without illusion thou mayest contemplate the full, lovely truth.

panion in 1878, also measured two small neighbouring stars which he estimated of "about the 13th mag." with these results—

(*a*) 1878·842	...	Position	49°·59	...	Distance	87″·209
(*b*) 1878·842	...	,,	197·85	...	,,	71·384

Secchi, in *Memorie dell' Osservatorio del Collegio Romano*, 1859, p. 119, publishes measures of "70 *p* Ofiuco preso colla più vicina," thus :—

1856·627	...	215°·08	...	87″·574	(4)	...	11m.
1856·627	...	67·2	... ...	...	(4)	...	12m.

The proper motion of 70 Ophiuchi by comparison of Bradley with the Greenwich catalogue of 1872, appears to be +0″·2014 in right ascension, and −1″·1170 in declination, and transferring with the aid of these values Hall's angles and distances to Secchi's epoch, we find :—

(*a*)	...	1856·627	...	190°·63	...	94″·38
(*b*)	...	1856·627	...	65·89	...	77·65

It can hardly be doubted that Secchi's stars are identical with Hall's, but the difference in both position and distance of the star (*a*) seems to merit further examination; if there be no error in Secchi's measures proper motion of the thirteenth magnitude, as Hall estimated it, is probable.

Smyth refers somewhat vaguely to two small companions of 70 Ophiuchi; at his first date the Washington measures carried back as above would give :—

(*a*)	...	1830·76	...	87°·9	...	76″·1
(*b*)	..	1830·76	...	185·7	...	122·3

THE GREAT COMET OF 1874.—Mr. T. W. Backhouse writes from Sunderland, pointing out that the tail of this comet attained a much greater length than was assigned in this column, p. 483. The length there mentioned 23°, was that given by observation in the suburbs of London on July 13, when the head of the comet was about to descend below the horizon. On the same evening Mr. Backhouse found the tail 26° long, and 35° on the 14th, and he refers to greater lengths subsequently noted. These, however, refer to dates when the head was no longer visible in these latitudes, Prof. Julius Schmidt gave the following estimations made at Athens :—

July 16 ...	47°·2	July 18 ...	55°·9	July 21 ..	65°·8
17 ...	54·0	20 ...	63·3	22 ...	64·6

These, with other observations, will be found in his description of the appearance of the comet, in No. 2067 of the *Astronomische Nachrichten.*

BIOLOGICAL NOTES

COLOSSAL CUTTLE-FISH.—Mr. T. W. Kirk adds to our rapidly-increasing knowledge of large cuttle-fish in an important paper lately published (*Trans.* New Zealand Institut. vol. xiv). One species referred by him to Steenstrup's genus Architeuthis, and called *A. verrilli*, was found stranded at Island Bay, Cook's Strait, New Zealand, in June, 1880. When first found on the beach, it was not quite dead; the longer arms measured twenty-five feet; the blades had a row of fifteen suckers along each side and a middle row of nineteen. The smaller arms were about eleven feet nine inches, with a width of seven and a half inches. They were furnished with suckers and fleshy tubercles, but these shorter arms were of unequal length. The fleshy membrane connecting these was about eleven inches deep. The head was four feet three inches in circumference, the eyes five inches by four; the body was seven feet six inches in length, and nine feet two inches in its greatest circumference. While this large cuttle differs in some respects from the type of Steenstrup's genus, Mr. Kirk prefers to wait for fresh material ere creating a new genus. Another large cuttle is referred to a new genus, Steenstrupia, but its long pair of arms had been torn off at a length of six feet two inches, when it was found in Cook's Straits; its body was long (nine feet two inches), almost cylindrical, but very slightly swollen in the middle, head long (one foot eleven inches), narrow sides, nearly straight, eyes larger, and with lids, sessile arms, all same length and size (four feet three inches), suckers, thirty-six on each arm, in two equal rows, each with a bony ring armed with from forty to sixty sharp incurved teeth. The fin was rhomboidal, posterior lateral. The internal shell was six feet three inches long. The new species is called *S. stockii.*

JAPANESE COTTON.—The Japanese Government have lately presented to the National Museum of the United States an interesting collection of cotton grown in Japan, accompanying the donation with notes on the specimens, from which we extract the following :—Cotton is produced along the coasts of the districts Kinai, Kanto, Chiugoku, and Kiushiu, where the soil is sandy and the climate warm. In some of the north-eastern parts, where there are early frosts, the attempt to cultivate cotton is rarely made. It is uncertain when the cultivation of cotton in the Japanese empire first commenced, but it would appear that the method of culture adopted in the western provinces came from Kinai, though the seeds grown in the eastern provinces came from Mikawa. In the province of Settsu the crop is the largest, indeed is not surpassed by that of all the other provinces, but the cost of cultivation is high. The staple, moreover, is rather short and hard, so as not to be suitable for very fine yarns. In recent years, however, cotton yarns are imported on a large scale, and fine yarns are easily procured; so the home-produced cotton is profitable in proportion to its yield. This will account for the fact that the cultivation of the long and soft staple is quickly passing away, and that it is becoming the almost universal custom to grow only that seed which will produce a maximum yield. While cotton plants have different names in the different provinces, it is believed that there are but three sorts—the Kanto, which produces a long, soft, and strong staple of glossy appearance, from half to two-thirds of an inch in length, the Kinai, with a hard and short staple, from a quarter to half an inch in length, and rather destitute of glossiness, and the Ainoko, which is a hybrid between the two former. The cultivation of the cotton-plant in Japan is not uniform, varying immensely according to not only the climates and soils, but also according to the customs of each district, but it is to be expected that with the advance of time the mode of culture may become more uniform, and that excellence in quality may even take the place of a maximum in quantity.

AMERICAN WOODCOCK CARRYING ITS YOUNG.—Whilst it is still somewhat uncertain whether the woodcock (*Scolopax rusticula*, Linn.) of Europe carries its young in its claws or between its legs, we believe this habit has, though referred to by Audubon, not been recently observed in the American woodcock (*Philohelia minor*). It is, therefore, interesting to note the following observations of Mr. F. L. Harvey, of Arkansas. In April last (1882) a woodcock was flushed from a clump of persimmion trees on the border of a slash. Knowing the bird's habit of rising above a clump of bushes and then suddenly dropping behind it out of range, Mr. Harvey fired as soon as it rose. When the smoke cleared away the bird was seen rising with a laboured flight, and concluding it was wounded its fall was expected, but instead it turned and came nearer. It was seen to be holding something between its feet, which on closer observation proved to be a young chicken recently hatched, which was located between the mother's legs, and supported by her feet placed on its sides. So slow was the flight that by a brisk trot the observer was able to gain on the bird, which he tried to tire out so as to compel it to drop its burden, but in this he was not successful. It would appear that this bird and Wilson's snipe often remain in Arkansas to breed (*American Naturalist*, September).

BLIND SUBTERRANEAN CRUSTACEA IN NEW ZEALAND.—The existence of blind Edriophthalmatous Crustacea in wells and subterranean cave rivers in Europe has been long known, and now Mr. C. Chilton describes some quite new forms found in New Zealand (*Trans.* New Zealand Institute, vol xiv.). They were obtained from a well at Eyreton, about six miles from Kaiapoi, North Canterbury; the well had been excavated about seventeen years previously, was not more than twenty-five feet deep, and was fitted with a common suction-pump through the medium of which these new forms were obtained. These proved to be three species of Amphipoda and one of Isopoda. In none were there to be found in either the living or recent specimens the least trace of eyes. The Isopod is referred to a new genus Cruregens, and is most remarkable from the fact that it has only six pairs of appendages to the seven thoracic segments, whilst the normal number should be seven. In many Isopods the young have at first only six pairs of legs, the last thoracic segment being but slightly developed and destitute of appendages (Fritz Müller, "Facts and Arguments for Darwin"), and hence at first sight it might appear that the new form was but an immature state. Mr. Chilton, however, states that he has examined altogether twenty live specimens, none of which seemed otherwise to have anything immature about them, and these were obtained at various times from January to October, 1881, he would, therefore, refer the absence of the seventh pair of appendages to an arrest of development. In some respects the new genus resembles Paranthura of Spence Bate. The new species is called *C. fontanus*. The Amphipods found with this Isopod are *Cragonyx compactus*, sp. nov., *Calliope subterranea*, sp. nov., and *Gammarus fragilis*, sp. nov., all without eyes. The new species are all figured, and at great length described.

GEOGRAPHICAL NOTES

MR. STANLEY has returned to Europe, after an absence of between three and four years, during most of which time he has been on the Lower Congo. From the station which he established at Vivi, below the Yellala Falls, his object was to make a road past the long line of cataracts, about 150 miles, to Stanley Pool. Much of the road has, we understand, been constructed, and five stations have been established. Mr. Stanley himself has been 300 miles into the interior, with what results to science remains to be seen. Meantime the French are diligently exploring the region lying between the Lower Congo and the Ogové, and have already done much to clear up its hydrography.

BARON NORDENSKJÖLD has under consideration an expedition to the Arctic next summer, and is engaged, in company with Mr. William Schönlanck, of Berlin, a gentlemen much interested in geographical discovery, who is at present visiting Stockholm, as to the detailed arrangements of the same.

THE Swedish Geological Expedition returned from Spitzbergen to Tromsö in the yacht *Bojna* on the 16th inst. It was found impossible to land at Beeren Island, as intended, owing to tremendous seas.

WE regret to hear of the death of Mr. Krarup Smith, who has, since 1867, been Inspector of the Northern Districts in Danish Greenland. During the past winter he suffered from constant sleeplessness, and he expired somewhat suddenly on May 28, aged forty-nine. Every traveller who has passed any time at Godhavn during the last fifteen years has spoken of the kindness and attention of Mr. Smith and his wife. He rendered important services to various Arctic expeditions, and freely placed his house and resources at the disposal of scientific workers—Nares, Markham, Hayes, Pavy, Whymper, Nordenskjöld, Steenstrup, and many others of various nationalities have experienced their hospitality or received their assistance. Although Inspector Smith was not of a robust constitution, he travelled extensively by boat and sledge in summer and winter throughout the Inspectorate, which extends over more than five degrees of latitude, and took much interest in the welfare of the natives, who sustain a real loss by his lamented death.

THE range of the changes of level in the rivers of Russia in Europe has become, since 1876, the subject of accurate measurements, and M. Tillo has just published in the Russian Nautical Review (*Morskoy Sbornik*) an interesting paper on this subject, being the result of measurements made at eighty different places. The highest range is reached by the Oka at Kaluga, the difference between the highest and lowest levels being as much as 45 feet; the average range for the same river from its source to its mouth being 32·2 feet; the average for the Volga from its source to its mouth is 33·6 feet, 30·1 feet for the Kama, 25·2 for the Duna, and 23·1 for the Don. For all other rivers the range is less than 20 feet. Of course this range diminishes very much towards the mouth of each river; but still it reaches 12 feet for the Volga at Astrakhan, and 9 feet for the Duna at Riga. The highest range observed in the lakes of Northern Russia was only 2·1 feet. A map prepared by M. Tillo shows the distribution of hydrometrical stations on Russian rivers, their numbers having been increased in 1880 to 341 stations.

WE regret to learn that the *Neptune*, which was chartered by the American Government to take supplies to the Greely Scientific Expedition, in Lady Franklin Bay, in 81° N., has returned to St. John's, Newfoundland, and reports being unable to get further north than 79°20, owing to an impenetrable barrier of ice. She, however, landed supplies at several ports. From the precautions which have been taken there is, we believe, no danger of the U.S. Polar observing party being in straits for want of food. The fact of the *Neptune* being unable to get north, combined with the news of the early imprisonment of Lieut. Hovgaard's expedition on the coast of Novaya Zemlya, seems to indicate an exceptionally early and severe Arctic winter.

IN the last number (fasc. 3 tome 7) of the *Bulletin* of the Antwerp Geographical Society will be found an interesting discussion on the subject of geographical orthography, and the preparation of maps generally. The president took objection to the distinction made by the Commission to consider the subject between scientific maps and maps for common use. He recognised, he said, only one kind of maps, and that was *good maps*, which indeed might be made to bring into prominence certain features for special purposes. All maps should be constructed on rigidly scientific principles, most of all those for common and school use.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

AT King's College, London, Prof. W. Grylls Adams, F.R.S., will deliver a course of lectures on Electricity during the ensuing session. A course of practical work in electrical testing and measurement with especial reference to electrical engineering will also be carried on under his direction in the Wheatstone Laboratory. The lectures will be given once a week on Thursday, at 2 p.m., and the laboratory will be open daily (Saturday excepted) from 1 to 4.

AT Owens College Prof. Arthur Schuster, assisted by Mr. W. Haldane Gee, will give a theoretical and practical course on the modern applications of electricity one evening a week during next winter. Beginning with the ordinary electrical measurements it is intended to include the usual tests of terrestrial and submarine telegraphy, the construction of telephones, electro-dynamo machines, and all measurements connected with electric lighting.

THE Calendar of Yorkshire College for the ninth Session has just been issued. In addition to the usual information, we note that Prof. Rucker, who has secured a new assistant-lecturer in the person of Mr. C. Spurge, B.A., of Cambridge, proposes some additional work in his Senior Mathematical Class, and, what is of more importance, to add a Third Year Course in the department of Physics. The lectures and laboratories in the Chemical, Geological, and Biological departments, under Professors Thorpe, Green, and Miall respectively, as well as the classes generally, are to be continued as in last session. In the Textile Industries Department Mr. Beaumont has added a third year's course for such of his students as require it. In the Coal-Mining Department the recent alterations in the curriculum will come into full operation at the beginning of this next session. The course is in future to occupy two years, and will include lectures by the Professors of Chemistry and Geology, as well as instruction in practical coal-mining by Mr. A. Lupton. A boon to science teachers has been granted in the shape of Assisted Studentships, under which a teacher may work in the college laboratories on payment of one-fourth of the fees, Government paying the other three-fourths. We may add that the Yorkshire College has, at the present time, about 700*l*. a year to distribute in scholarships.

THE Marquess of Ripon, Viceroy of India, in a letter expressing his warm approval of the decision of the Council of the Yorkshire College, Leeds, to raise a memorial to the first president, the late Lord Cavendish, in the form of a Professorship of experimental physics, announces his intention of subscribing 500*l*. to the fund, which now amounts to 3000*l*.

FROM the Calendar of University College, Nottingham, we see that the teaching staff is well filled up, nearly all branches of a really liberal education being represented. From the interesting statistics given, it is evident that the institution is very largely taken advantage of. The Calendar gives an account of the origin of the College.

THE Winter Session of 1882-83 of the London School of Medicine for Women (30, Henrietta Street, Brunswick Square) will open Monday, October 2. Courses of lectures will be given at the school on Anatomy, Chemistry, Physiology, Practice of Medicine, and Practice of Surgery. A course of Practical Anatomy, with demonstrations, will also be held. Lectures on

Clinical Medicine and Clinical Surgery will be delivered at the Royal Free Hospital, where daily clinical instruction will be given to the students. The number of students admitted since the foundation of the school in 1874 has been 100.

THE new University at Lund was opened on the 26th inst., great preparations having been made for the ceremony. The principal universities of the continent were represented through deputations.

SOCIETIES AND ACADEMIES

SYDNEY

Linnean Society of New South Wales, July 26.—The following papers were read:—Botanical notes in Queensland, Part 3, by the Rev. J. E. Tenison-Woods, F G.S. This paper contained the results of the author's observations on the Mulgrave River, with a list of the species collected by him in that district.—On the forage plants indigenous to New South Wales, by Dr. Woolls, F.L.S.—Description of three new fishes of Queensland, by Chas. W. De Vis, B.A. The species described by Mr. De Vis are:—1. *Oligorus Goliath*, taken in Moreton Bay, a fish of gigantic size, seven feet long, and two feet high. 2. *Synaptura Fitzroiensis* from Rockhampton; and 3. *Engraulis Carpentariæ*, from the Norman River.—4. Description of a species of Squill, *Lysiosquilla Miersii*, from Moreton Bay, by Chas. W. De Vis, B.A. This Crustacean, which is found in Moreton Bay, differs materially, according to Mr. De Vis, from the two species of the same genus recorded in Mr. Haswell's Catalogue, which belong to Mr. Miers' second section of the genus, while the present species agrees with his first section.—On *Cypræa citrina* Gray, from Rowley Shoals, North West Australia, by John Brazier. C.M.Z.S.—On a variety of *Ovulum depressum*, from the Loyalty Islands, by Mr. R. C. Rossiter.—Notes on the nidification of the spoon-bill, the heron, and the night-heron, by Mr. K. H. Bennett.

VIENNA

Imperial Academy of Sciences, July 15.—L. I. Fitzinger in the chair. The following papers were read:—F. Lorber, a contribution to the determination of the constants of the polar planimeter.—Ph. Knoll, contributions to the theory of respiratory innervation (third communication).—H. Satter, contributions to the history of development of the antheridium of liver-wort.—C. Huellner, on the influence of great amplitudes on the oscillations of elastic bodies.—E. Lippmann and F. Fleissner, on Azylines, a homologous series of azotic bodies.—F. Heindachner. contributions to the knowledge of the river-fishes of South America.—C. Etti, on the combinations of vanillin with pyrogallol and phloroglucin.—L. v. Barth and I. Schreder, on the action of melting caustic potash on orcin and gallic acid.—J. Habermann and M. Hoenig, on the action of cupric hydroxide on some sugar species.—M. Hoenig and F. Berger, on the action of chloroform on naphthalene in presence of aluminium chloride.—C. Nachbaur, examination of the embryos of ingerminated rye, especially on their contents of diastase.—C. Zatzek, to the knowledge of bees-wax.—S. Schubert, on diisobutyl-hydroquinones and some of its derivatives.—F. Exner, on some experiments relating to the contact-theory.—L. Hartinger, on the occurrence of organic bases in the merchantable amyl alcohol.—A. Waage, on the action of ammonia on propionaldehyde.—J. Fruehling, on oxybutyric acid.—B. Brauner, on some earth contained in cerite.

PARIS

Academy of Sciences, September 18.—M. Blanchard in the chair.—The following papers were read:—Note on the life and works of M. Emile Plantamour, by M. Faye.—On marsh-fevers, by M. d'Abbadie. Immunity from such fevers in bad Ethiopian regions is often secured by sulphur-fumigations on the naked body. In Sicily the workmen in sulphur-mines on low ground suffer much less from intermittent fever than the rest of the population. In Greece (M. Fouqué has shown), a once flourishing town of 40,000 inhabitants, Zephyria, has been almost utterly depopulated through marsh fever; and its decadence has corresponded to a transference of sulphur-mining operations to the east, so that the sulphur-emanations are prevented, by a mountain mass, from reaching the site of the town; (other similar facts are given).—Geological and historical considerations on the great deserts of Africa and Asia, by M. de Tchihatcheff (Abstract of a British Association paper).—Separation of gallium (continued), by M. Lecoq de Boisbaudran.—Study on the *régime* of the maritime Loire, by M. Bouquet de la Grye. Between Nantes and Saint Nazaire there is deposited annually about 590,000 cubic metres of sand and mud. The volume of the channels has diminished about 56,000 cubic metres annually, for sixty years. The outer bar of the river has risen 0·70m. since 1864, and will probably rise more, presenting a danger for large vessels coming to Saint-Nazaire. The author indicates means of bringing the river back to its former constitution, such as replanting, covering slopes with turf, and he suggests a plan for carrying off quickly into the sea the 40 million cubic metres that have been deposited during the last sixty years.—On the permutation of *n* objects and on their classification, by M. Bourgot.—Absorption by the epidermis of aërial organs, by M. Cornu. A substance emitted in the form of vapour may traverse the epidermis (though very thick) of aërial parts of a plant, and be absorbed without previous dissolution in water. (The experimental case was that of growing grapes exposed to the vapours of heavy oils from distillation of coal tar. The empyreumatic substances were concentrated, as judged by taste, in the central part of the pulp and the bulb of the peduncle.)—The squares of forces of induction, produced by the sun in planets, and due to the velocity of revolution of these bodies, are, all other things equal, in inverse ratio of the seventh powers of the distances from the star; induction of comets, bolides, and falling stars, by M. Quet.—On a refractometer, for measuring the indices and the dispersion of solid bodies, by M. Soret. He modifies Kohlrausch's refractometer, which has the disadvantage of requiring monochromatic light, and so is unfit for researches on dispersion. A beam of parallel solar rays falls on a crystal immersed in a liquid more refringent, and of known indices; after reflection it is received on the slit of a spectroscope. With sufficient angle of incidence, all the visible spectral rays are totally reflected, and the spectrum is very brilliant. On gradually diminishing the incidence, the different rays attain in succession their limiting angle, and reach the spectroscope with intensity considerably lessened; thus a dark screen advances towards the violet. The line of separation in the spectrum, together with the incidence, afford data for arriving at the index.—Influence of temperature on the spectra of metalloids, by M. Van Monckhoven. He proves experimentally that the so-called high temperature spectra may be produced at very low temperatures, and *vice versâ*.—On the action of presence of plates of zinc in boilers, and on a process for avoiding explosions, by M. Trève. The hydrogen liberated with galvanic action should theoretically maintain the boiling (after having started it), and so prevent explosion as a result of super heating; for this, however, the plates must be carefully kept clean. The author thinks it well to add the continuous injection of gas (preferably carbonic acid), and so incessantly prevent the super-heating, which may be regarded as a *sleep* of the liquid.—On the winter of 1879-80, by M. Teisserenc de Bort. The exceptional cold is attributed to a displacement of the centre of high pressures of Madeira and the Azores, and to a perturbation in the barometric maximum of Siberia.—On the alteration of grape seeds by mildew, by M. Prillieux.

CONTENTS

THURSDAY, OCTOBER 5, 1882

FLUIDS

Experimental Researches into the Properties and Motions of Fluids with Theoretical Deductions therefrom. By W. F. Stanley. (London: E. and F. N. Spon, 1882.)

THE aim and general scope of this work is well described in its modest and explicit preface. It is essentially a tentative and qualitative treatise, the author expressing a wish in his preface that some highly educated mathematician who may care to follow him, will clothe with his skill the rude, but as he believes, natural underlying forms he has brought in some cases to light. Modesty such as this, undoubtedly tends to disarm criticism, but after a careful perusal of the work, we cannot help cherishing a sincere regret that the author does not himself happen to be the much desired mathematician. We feel certain that if this had been the case, many mistakes would have been avoided, much speculation curtailed, and the value of the work considerably enhanced. Thus while the author admits that "the eighth chapter is very incomplete on certain points for want of sufficient research into the works of others and more experiment," we find the work characterised throughout by a lack of the same knowledge of what is already known, or has been done by others.

Too often also the deductions appear to have been preconceived, and the experiments from which they are supposed to follow are either too rough, or of too special a nature.

As the author speaks disparagingly of his own educational acquirements, it would be unfair perhaps to criticise too harshly a literary style, which certainly detracts very much from the pleasure or comfort of studying his work. He might, however, have tried to be a little more clear, and somewhat less pedantic in the construction of his sentences. Almost every idea has to be disinterred from a heap of polysyllabic adjectives and adverbs, which most effectually obscure its meaning, while very often we meet with paragraphs of, at any rate at first sight, a most incomprehensible character. Such as the following:—"Such *equilibrium* acts as a *condensation* upon the surface of a liquid, thereby increasing the molecular surface density," or "the *area* of efflux of the liquid will be the mean of the directive *impulses* of vertical and horizontal pressures." Elsewhere he speaks of "a narrow *vacuous* plane" and "*motive* quiescence."

On the other hand there is much that is novel and worth perusal in the book, more especially in Chapters IV., V., VI., and VII., and in Section III. on waves.

One very prominent fault which we notice all through the work, is the almost entire absence of any distinction between the physical properties of compressible and incompressible fluids. The words fluid and liquid are used quite indifferently, and whatever principles the author deduces for water, are immediately and without trial assumed to be true for air and gases, and *vice versâ*. Again, the experiments which are mostly of a very simple and rudimentary character, are not sufficiently differential. Thus in experiments on liquids, water alone is employed, and in like manner air is the sole representative of the gaseous state, though in a work dealing with fluids generally, one might have expected to hear *something* at least of the properties of *all* the more easily procurable gases and liquids.

The first three chapters deal with the theory of the constitution and motive properties of fluids, and are, as the author admits in his preface, "speculative and even in parts hypothetical." In opposition to Clerk Maxwell and others, he holds that "Fluids are composed of *static* atoms, infinitely tough and elastic, their fluidity depending on the presence of gases or liquid vapours held by attractive forces upon the molecular surface and intruded intermolecularly, the surrounding envelope of gas acting as a lubricant to the motions of the molecule composing the liquid proper."

This system of gaseous atmospheres surrounding the molecules is supposed to extend to all matter, and expansions by heat forces to vary as the powers of evaporation of the separate molecules. From this point of view the author attacks the theory which has been considered to satisfactorily explain the phenomena observed by Mr. Crookes in high vacua. He maintains that such phenomena are not due to the projection of the molecules of the residual gas, but to convection currents of gas formed of metallic matter composing the negative pole. He does not, however, attempt to give any adequate explanation of several of the accompanying appearances observed, such as molecular shadows, and phosphorescence, the circumstances attending which, so strongly favour the theory of the rectilinear propagation of the free molecules of residual gas, which depends, as Mr. Tolver Preston has lately suggested, on "the relative dimensions of the containing vessel to the mean path of the molecules," and are so completely inexplicable by the physical properties of any ordinary convection current.

In his preface, the author says he ventures to differ from the generally accepted theory of tensile surfaces for liquids, and prefers to consider them extensile. In Chap. II. he thus defines these words:—

> "By tensile I intend a disposition of the parts of a system of matter to draw themselves together as a stretched drumskin does. By extensile I intend the reverse of this, or the disposition of the parts of a system of matter to separate, and thereby to engender external pressures."

He then proceeds to show how, according to his theory of the constitution of liquids, the surface (except in the case of free films) has a tendency to extend by virtue of surface condensation arising from the cohesive force between the superficial molecules.

We fail, however, to see how this assumed surface condensation gives rise to extensibility, since no force other than a strictly lateral one can act at the surface of a liquid without being equally felt all through it, while it would obviously be arguing in a circle to say that *lateral* attraction of superficial molecules produced *lateral* extension of the surface.

Moreover the author assumes that a tensile surface is one which is so stretched already, that it would give way under any additional pressure, while extensile is used to mean not so much disposition to extend, as capability of stretching.

Thus the familiar experiment of the needle floating on water, would the author thinks, be impossible were the surface tensile. Doubtless, according to the author's definition of tensile, it would be so, but we think it would be equally impossible unless the surface were endowed with a tolerably high tension, such as water is known to possess.

We find it impossible also to accept the author's explanation of the various capillary phenomena on the same hypothesis. To take the case of capillary elevation and depression alone. If the surface force on a liquid is extensile, it can be easily shown by reversing the reasoning given in the ordinary physical text-books, that in the case of capillary elevation, the free surface would be convex, and in the case of capillary depression, concave, conditions, precisely the opposite of those which actually take place. The same hypothesis is equally unsuccessful when applied to the resolution of jets into drops. Mr. Stanley considers drops to be formed when the mass cohesion of a jet is equal to the extensibility of its surface, and in order to show that this is the principal cause, he falls into the serious error of imagining that a jet of liquid (water is the only one mentioned) issuing from a small orifice, *continually* expands in sectional area beyond the vena contracta, whether the stream be directed *upwards* or *downwards*, the final resolution into drops being due to such expansion caused by extensibility. We know, however, that this cannot be the case, since although the jet expands slightly beyond the vena contracta, in accordance with the equation of continuity it again *contracts* if flowing downwards, and the reverse if flowing upwards, and since in either case, whether in waterfalls or fountains, the jet ultimately becomes converted into spray, the author's explanation is obviously erroneous. It is to be regretted for many reasons that in dealing with this interesting though difficult subject of surface tension and capillarity of liquids Mr. Stanley makes no mention of the researches of Van der Mensbrugghe, Tomlinson, Duclaux, or of the very remarkable results obtained not long ago by Cintolesi, and that while the names of Young and Laplace are mentioned once, not the smallest account is given of their researches

Chapter III. chiefly relates to the conditions of the efflux of liquids through orifices. A great deal of it is almost unintelligible from the obscurity of the language employed, and the loose way in which the expressions, energy, weight, velocity, force, and volume are employed as though they were identical.

As far as it is possible to glean anything definite from such a chaos, it would seem that the author thinks the known contraction which takes place in the area of efflux of a liquid through a vent, is due to horizontal elastic compressions caused by the reaction of the vessel against the pressure of the liquid it contains. No reference is made to the Torricellian equation, which according to the author's notation should take the form $v^2 = 4gh$; instead of $2gh$ as ordinarily; or to the theoretical results got with different forms of orifices on the parallel section hypothesis. We do not think the author has got on the right tack here. The horizontal velocities which must necessarily arise, either from the natural or artificial narrowing of the descending column, and which are disregarded by the parallel section hypothesis, may be readily conceived to act so as to contract the area of vertically descending liquid, and not elastic compressions, which have little place in the dynamics of a practically incompressible liquid.

In Chapter IV. the author tries to show that the general relative motion of fluids on solid surfaces or in other fluids is effected by means of rolling contact. The hypothetical case of a plane supported on equal rollers, and moving on a parallel plane is taken, and the analogy to this pointed out in different cases, such as where a river moving relatively to its bank causes small lateral eddies, or where larger rotatory movements are produced in the bays or widenings through which it flows. Several instances apparently exhibiting this kind of motion are noticed, but we cannot agree with the author that such examples conclusively prove his theory, and that no sliding takes place. The internal molecular friction or viscosity of most liquids, must necessarily cause rolling contact, if it occurs at all, to take place in a very imperfect manner, and at the same time admit of sliding with a certain amount of friction.

In Chapter V., which treats of the resistance of fluids to the projection of fluids or solids within them, Mr. Stanley develops some novel nomenclature, and a principle of considerable importance which may be briefly enunciated as follows:—When a mass of matter strikes a fluid such as water, it fractures a conical part immediately in front of it, called the cone of impression, from the surrounding mass called the conoid of persistion, and intrudes itself into the fracture, which is called the plane or cone of infraction. This principle, which is frequently appealed to in subsequent portions of the work as one of fundamental importance, and on which a host of minor propositions depend, is derived from an analogous principle of conic fracture in the case of solids, and is supported in the case of liquids and gases by various experiments, such as the shape assumed by a leaden bullet shot vertically into water, the ring formed by a drop of coloured dropped into uncoloured water, and the phenomena of smoke-rings as shown by Prof. Tait. The experiments are clear, and the idea is skilfully and consistently worked out as far as it goes.

Whether all the properties of vortex-rings will be found to accord with this principle, is a question which may be safely left to those who make such matters their special study, but at all events the explanation given of the smoke rings, and the experiments showing the absence of a motive axis, are decidedly ingenious.

From the foregoing principles the author proceeds to deduce in Chapter VI. the conditions for the *continuous* motion or projection of fluids within fluids, in which rolling contact again comes into play, through the final rotation of the conoid of persistion, and the formation of whirl and biwhirl systems. Several interesting experimental examples of such systems are described and figured, and some of the laws which apparently regulate such systems are proposed, though the proofs appear to rest solely upon a somewhat limited ocular experience.

Towards the end of this chapter is introduced the well-known paradoxical fact first noticed by Clement Désormes and Hachette in 1826, that a blast of air or stream of water flowing in their respective fluids, apparently attract towards themselves flat bodies placed directly in their paths, and an endeavour is made to account for it in a not very obvious manner, by means of certain backward forces arising from induced whirl-systems. Whether some small portion of the phenomenon may not be due to an induced reflex action, is a point worthy of investigation, but the major portion is generally admitted to be due to a principle with which, the author, since he entirely omits all reference to it, is apparently unfamiliar, viz. that the pressure both of compressible and incompressible fluids is diminished by an increase of velocity. A conclusion drawn by the author from an experiment on p. 276 is similarly invalidated by the omission of the same principle.

The way in which fluid moves in pipes or channels is described in Chapter VII., and is concluded to be by rolling contact on a continuous system of lateral whirl-rings, "these being alternately collected by reflex action, that converts these whirls into loops, which permit the deflected fluid to re-enter (in a hypercycloidal curve) the central system by traction."

The same principle of rolling contact and the development of whirl-systems is, in Chapter VIII., applied to the motions of solids through fluids, more particularly of ships, through water. The eddies, for example, which we ordinarily observe at the rear of boats are regarded by Mr. Stanley, not as resulting from the meeting of two relatively opposed currents, but as friction rollers engendered by the passage of the body through the liquid. The general effects of rudders on the motion of ships, and the peculiar cases noticed by Prof. Osborne Reynolds and others, are ascribed to the position and influence of such whirls, and not to the mere deflection of stream lines. Although a good deal of what the author says on this point is, as he admits himself in the preface, very speculative, and though the theoretical action from which it all proceeds is not very plain, there is much that is suggestive and worthy of study.

Section II. is devoted to a consideration of Oceanic and Aërial Systems of Circulation, which are assumed to be gigantic whirl systems arising from the projection of water within quiescent water, or against solid areas of resistance such as capes and promontories. A good deal of the matter usually found in treatises on physical geography is here reproduced, as to the general forces in action to disturb equilibrium, but in the case of general oceanic circulation, too much importance is, we think, attached to the thermal causes of circulation discussed by Lenz and Dr. Carpenter, and too little notice taken of the effect of prevailing winds in causing at least superficial ocean currents. Nothing very fresh is adduced in explanation of the causes of the currents as they are at present known. The main currents, such as the Atlantic equatorial, are assumed to exist, and all the author does, is to try and arrange them as large circles or whirls to suit his whirl theory, and which please the eye just in proportion as they diverge from the truth and irregularity of nature.

We do not doubt that the currents occasionally take the form of whirls such as those exhibited by the author, since their deflection by continents and the continuity of the circulation, requires the water to flow more or less in closed curves, but we cannot agree with the author's view that the Southern Polar drift current is simply a huge whirl, set spinning round by the tangential forces exerted by the whirl systems of the South Atlantic and South Pacific. We prefer the simpler and more rational view that it is a result of the constant and similarly directed wind system of that region. Another view indulged in by Mr. Stanley on p. 377 that the southward pointing of the continents is due to action of ocean currents acting through countless ages, is not more probable than the astronomical hypothesis that this is due to a northward motion of the earth in space. Besides, the abyssal character of marine basins shown by Sir Wyville Thomson, forms a positive objection to any such notion.

The author's views of atmospheric circulation are not happy. For example, in his chart of the general system of air motion, which he tries to reduce to two large "ellipsoidal whirls" having their southern foci in June, near the east of the United States and China respectively, and which correspond roughly to the general motions traceable over the sea areas, we find the motion of the air over the western part of North America and the Indian peninsula distinctly contrary to what is known to occur at this season from observation.

It would indeed be a tedious task to point out all the questionable hypotheses or erroneous conclusions with which this part of the work teems. One or two, however, we cannot overlook. For example, the absurd idea that the prevailing south-west winds over the flat plains of Northern Europe, are an indraught to feed the cold and therefore contractile area of Central Europe and Asia. The author travels in vain all round Asia, in search of a current to satisfy the cravings of this contractile area; and this is the only one which has an approach to the necessary direction. We need hardly say that we are totally unable to credit our south-west winds with the ability to perform such a feat. Areas of cold air, are areas of contraction in a *vertical*, not *horizontal*, direction, and are fed by *upper*, not *lower* currents.

In another place we are told that directly under the sun in the tropical region there should be no cloud, owing to the vapour remaining *uncondensed under vertical solar rays*. At about 30° N. and S., however, there should be bands of cloud and constant precipitation. Now, as a matter of fact we know that the actual conditions are precisely the reverse of these. Thus in the tropics, whenever the sun becomes vertical over any region, he is invariably accompanied sooner or later by a band of cloud and consequent rainfall, while the areas 30° N. and S. are notably those of small precipitation and almost constant sunshine.

Again, we cannot agree with the statement on p. 444 that "all cloud systems by their superior weight will be descending," or that "condensation of vapour causes a descending area." The very continuity of the existence of a cloud is dependent on its forming part of an *ascending* area, since by well-known physical principles, if such an area once began to descend, the cloud would, *cæteris paribus*, almost immediately be re-absorbed and become invisible.

Another conclusion of the author's is in striking opposition to the doctrine ordinarily held by meteorologists; viz. that the cyclonic area is one of ascent, and the anti-cyclonic one of descent. Mr. Stanley says: "Upon the principle of whirl motions they would be the reverse of this," but we entirely fail to see how or why.

Altogether we are not favourably impressed with this part of the work, and do not deem it likely to accomplish the author's forecast in his preface, viz. "aid in the elevation of the sciences of physical geography and meteorology, now sciences of *observation*, to sciences of *principle*."

The last part of the work, treating of aqueous surface-waves, which we have not space to notice in detail, is a considerable improvement on the foregoing chapters. We are surprised, however, to see that while some notice is taken of the researches of M. Flaugergues and Mr. J. Scott Russell, no reference is made to those of the late Mr. Froude.

In conclusion, the type and illustrations are decidedly good, and though we cannot describe it otherwise than as a preliminary investigation into certain portions of the dynamics of certain fluids, accompanied by a good deal of speculation and deduction which still requires verification, and which is sometimes palpably erroneous, it nevertheless represents a very laudable, and to some extent successful endeavour on the part of the author to fill up a gap that admittedly exists in this abstruse branch of science. E. D. A.

HANDBOOK OF INVERTEBRATE ZOOLOGY

Handbook of Invertebrate Zoology for Laboratories and Sea-side Work. By W. K. Brooks, Ph.D. (Boston, 1882.)

THE series of notes and directions issued under this title by Mr. Brooks, of the Johns Hopkins University, Baltimore, is an interesting evidence of the progress which the practical study of zoology is making in American universities, and more especially of the valuable services which the Baltimore University is rendering to education in science. The book consists of brief notes describing the appearances of a series of invertebrate animals before and during successive stages of dissection or development, as the case may be. Diagrammatic sketches (for the most part original, or copied with a few original touches from English authors) are introduced into the text. The animals chosen by Mr. Brooks are the following:—Amœba, Paramecium, Vorticella, Sycandra (Calcispongiæ), Eucope (Leptomedusæ), Mnemopsis (Anthomedusæ), Asteracanthion, Arbacia (Echinid), Lumbricus, Macrobdella (Hirudinean), Callinectes (Brachyurous Decapod Crustacean), Cyclops, Acridium (Orthoptera), Anodonta, Loligo.

Concerning each of these forms the reader will find original remarks and often detailed observations illustrated by sketches. At the same time the writer does not pretend to offer us a series of monographs, but merely such notes as will be eminently serviceable to students in the laboratory. It is no doubt to American students and especially to Mr. Brooks's own pupils that this work will be useful. Such descriptions as that of the development of Arbacia, and those relating to the Medusæ, have their value immensely increased when it is possible to place in the hands of the student the identical material—or perhaps we should say the counterpart of that material—which has served for the preparation of the descriptions which re to guide the student's observation.

Though class-students in this country will not gain much assistance from Mr. Brooks's notes, professed zoologists will be interested in his treatment of the subject, and may glance with advantage at the more detailed sections, such as that on the Lamellibranch gill, on the anatomy of the Squid, and on the Medusæ.

If we ventured on a criticism, it would be to suggest a doubt as to whether the types selected and the relative importance given to their treatment are altogether such as would commend themselves to a teacher who aimed at introducing students to a wide view of animal morphology. Naturally enough, Mr. Brooks has given notes and drawings relating to several animals which he has been able to study attentively. It is, however, hardly wise on his part to repeat in a student's handbook the account of the development of the oyster which he has already published elsewhere. This account, which was inconsistent with the previous results of other investigators of molluscan embryology (my own included) has been recently shown by Horst to be based upon error. So, too, it would be well if in a new edition of his notes Mr. Brooks were to take into account the later results which have been obtained as to the anatomy of the earth-worm and of leeches, and would revise both his drawings and statements in various sections of the book, where they touch upon distinctly histological matters.

The day is not far distant when we shall see inscribed over the door of every zoological laboratory, "Let no one enter here unversed in histology." Geometry was not less indispensable for the intelligent student of Greek science than histology is rapidly becoming for the modern zoological student. The question is how to find time (except in countries where time is *not* money) to make the student first a histologist, and then a zoologist.

E. RAY LANKESTER

OUR BOOK SHELF

Cameos from the Silver-land; or, The Experiences of a Young Naturalist in the Argentine Republic. By E. W. White. 2 vols. Vol. II. (London: J. Van Voorst, 1882.)

THIS second volume has been slow to make its appearance, having been printed at Buenos Ayres. It gives an account of the author's voyage up the Uruguay, his trip to Rioja, Catamarca, and Tucuman, a journey to Salta, and a voyage down the Paraná. There is a good deal of interesting information in this volume, though it contains very much less natural history than we expected. The wonderful resources of the Republic are well brought before us, resources only too feebly made use of; for it is a land of promise teeming with treasures, with a splendid river porterage, and needing only labour and capital to become very great. To a reader wishing to know the actual state of things at present existing in this country we can recommend these two volumes of Mr. White's as most instructive reading.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Recent Aurora

LAST night, between 8 and 9 p.m., there was visible here a very fine display of Northern lights, the finest indeed that I have yet witnessed. The sky was nearly unclouded, and the moon had not yet risen; a band of light forming an arc extended from west to east, under the Polar Star. It just touched, by its upper boundary, the stars γ and β of the Great Bear, and nearly touched by its lower fringe the star Cor Caroli; this gives some idea of its breadth. Beams of light extended from the upper fringe towards the North Star, with greater or less intensity, fading away, however, very rapidly. Towards 9 30 p.m. the eastern end of the arc became very luminous; immense beams spread up into the heavens, mostly parallel to the direction of the pointers. On the extreme east, a portion of the aurora presented that beautiful violet tint which is so relatively rare in these latitudes. Some of the beams towards the centre of the arc also presented this colour, but only momentarily.

The arc, varying in intensity from moment to moment, rose towards the North Star, and became diffused, and towards 9 o'clock, the moon then appearing, nearly entirely disappeared; faint beams still, however, showing themselves from time to time. The summit of the arc was as nearly as possible under the North Star.

J. P. O'Reilly

Royal College of Science for Ireland, Dublin, October 3

A bright aurora was seen here last evening (October 2). When first observed, at 7.0 p.m., the arc in the north-west was very distinct; at the same time two cloud-like patches of light were seen in the north-east at an elevation of about 30°. At 7.10 the display reached its greatest brilliancy, narrow streamers extending upwards from the arc, as frequent intervals; several pale flashes of light taking place over the arc. At this time the light patches had been replaced by others, and several new ones had appeared rapidly, the whole series forming a large arc springing from the east-north-east point, and extending towards the west-south-west, at 7.20 nearly forming a complete arch. By 7.30 the sky had become much overcast; still the strong glow continued in the north-west, while a lighting up of the clouds indicated the continued occurrence of the light patches. At 9.30 the sky was clear again, and every trace of aurora had vanished. The light of the aurora was quite colourless.

Kenley, Surrey, October 3 Sydney Evershed

Last night, the 2nd inst., I here witnessed a very fine specimen of the *Aurora Borealis*. It was in the form of radiating lines or ribs, having spaces between, equal to the width of the ribs, namely, equal light and equal shadow; the whole springing from a centre about 15° from the zenith in a south-westerly direction. When I first perceived the light, at 6.45 p.m., it was faint and of the colour of moonlight, and was not distinctly traceable all over, but by filling up the void, in the mind's eye, the whole gave the appearance of an immense dome. Fifteen minutes later it had all disappeared, but at 7.15 it began to flash out in different places like slow lightning, principally at the zenith, much brighter than before, but still of the same colour, and around the centre the light took the shape of a sort of eccentric vortex ring.

W. J. Lineham

University Club, Newcastle-on-Tyne, October 3

About a quarter to seven this evening I became aware that an aurora was in the sky. A clear, persistent light showed itself near the northern horizon, whilst in the eastern sky fluctuating luminous regions formed an arc between 7h. and 7h. 15m. I noticed the position of that arc with respect to the constellations Aries and Pegasus. It began under α and β Arietis, at about, say, 5° north of the equator, and stretched parallel to a line through γ and α Pegasi, also at about 5° north of the equator. At times the arc extended further towards the south-western horizon. At about 7h. 30m. a remnant of the arc shot a ray diagonally to the square formed by the four stars of Pegasus, *i.e.* from γ to β Pegasi. The colour of the aurora was pale white in the northern light; in the arc it was white, approaching slightly to a green approximate to that of the magnesium light.

Gustave Plarr

22, Hadlow Road, Tunbridge (Kent), October 2

A rather uncommon display of aurora was seen here last evening, from about 7.15 to 7.40 p.m. Large patches of light, brilliantly white, were seen in the south and south-east, at a rough guess, extending from 10° to 15° in length and breadth, sometimes shifting quickly from place to place, at others remaining stationary for a minute or two, but not attaining a greater average altitude than 30° or 40° from the horizon. They were slightly convex at the base, giving the appearance of a bank of clouds below. On looking to the north, a long, low arch of light was visible, with one or two long streamers, which rapidly disappeared, but the brilliancy was nothing compared with the patches before mentioned.

In connection with this display, perhaps it may be as well to mention that not only is there an enormous sun-spot passing over the sun's disc, but five other groups, one of which was nearly central yesterday, and showed signs of great disturbance in the course of a few hours.

Elizth. Brown

Further Barton, Cirencester, October 3

An Insect Attacking a Worm

On September 19, 1882, I was waiting for a train at Laqueville, in the Puy-de-Dome district of France, when I noticed a very large worm in the meadow, moving very rapidly from side to side. I touched it with my umbrella, expecting to see it retire into its hole, but, taking no notice of my touch, it continued its forward movement, and drew itself out of its hole with a jerk. I then saw that attached to the end of its tail was a caterpillar-like insect—no doubt the larva of some beetle—about 1¼ inch long, the back covered with a series of shining black bands, and the belly, which was furnished with a few short feet at the head and tail, was of dull greenish yellow. This insect, without relaxing its hold of the worm, which was moving along more rapidly than I ever saw a worm move before, gradually shifted its bite along the belly of the worm till it had bitten about two inches, or rather less than one-third the whole length of the worm, which was more than six inches long. This it accomplished in about ten minutes, the bitten portion turning livid and swelling considerably, the worm's power of motion gradually ceasing. The insect then relaxed its hold, and crawled back along the back of the worm, and, seizing its tail, attempted to drag it backward, but finding the worm had still the power of slightly moving forward, it rapidly bit the belly of the worm where it had previously bitten it, and by this time the worm's power of forward motion had entirely ceased. The insect then appeared to survey the ground for some two feet behind the worm, and again seizing the tail, and fastening its own tail to a stalk of clover, it pulled strongly, not directly, but bending the worm sideways round a stalk of grass; gradually, very gradually, the swelled tail of the worm lengthened, and then I saw the whole body come back as it were a ring at a time, with a sort of resilient motion. The insect thus gained about one quarter of an inch, and in an hour and a half had drawn the worm in a sinuous line about 9 or 10 inches. I was unable to observe longer, but I have no doubt the insect would eventually drag the worm back into the latter's own hole, where it had first attacked it.

No doubt such an incident is extremely common in France, where there are few birds, but I fancy the numerous birds in England may have nearly extirpated such an enemy of worms, which would form with the dead worm a somewhat conspicuous object for two or three hours.

Edwin Lawrence

White Ants

Having observed in Nature (vol. xxvi. p. 343) some remarks regarding White-ants' nests, it has occurred to me to put on record the following fact, which came under my observation.

A lady residing in Madras had a set of plain table glass ware in a cupboard, which had not been opened for some time. On looking into it one day, she found the glass more or less covered with the mud indicative of the presence of white-ants. The glass articles were at once removed and washed, but wherever the mud had been applied by the insects, it was found that the glass had a frosted appearance, which no amount of scrubbing would remove. Some of the articles were then sent to me for inspection, and I found that the lustrous surface of the glass had been completely destroyed, as if by some powerful corrosive, wherever the ant-mud had been in contact with it.

We know well enough the substances used for etching on glass, but I shall feel obliged if any of your correspondents will explain how these insects managed to act on it in the destructive manner specified.

G. Bidie

Museum, Madras, September 3

BRITISH SPONGES[1]

NEARLY twenty years have elapsed since the publication of the first volume of Dr. Bowerbank's "Monograph of the British Sponges" by the Ray Society, and the posthumous fourth volume, just published, has been edited, with additions, by the Rev. A. M. Norman. That these four volumes contain an immense mass of facts and observations about our native sponges; that they in addition possess a really splendid series of illustrations, few will care to deny, and yet it must be difficult for a student of the more modern school of biological science to fairly appreciate them. The descriptive and physiological portions of the first volume, despite the quarter of a century spent by the author thereof in the preparation of his work, are apt to excite one's surprise, while the profound ignoring by Dr. Bowerbank of the work of co-temporary authors, leaves the description of the species in the second and third volumes often quite delusive.

Those naturalists who can look back for some thirty years or more will not find it difficult to account for all this. Leaving out of the question for the moment how little was then known about sponges, how clumsy and unscientific were the attempts to examine them, it is more important still to recollect how few were the opportunities in these islands of scientific biological training. Which of our universities gave any training in modern biological research? and the anxious inquirer as to the beginnings of life, as to the structure of its lower forms, as to the proper method of such research, could find no voice crying in the many colleges of our country.

Things have changed greatly since then, and the man who at the period referred to might have been treated as a master would now probably not be tolerated at all. The late Dr. Bowerbank, though as a youth fond of astronomy, chemistry, botany, and geology, received no scientific education. A partner in an extensive business concern, he amused his leisure hours with the pursuit of science as an amateur; of an active and pleasant turn of mind, we owe to him in great measure the origin of our Palæontographical Society, of the Microscopical Society, and also of the Ray Society.

In 1841 a storm occurring while he was at Brighton threw a mass of sponges on the beach, and for the next thirty-five years Dr. Bowerbank made the group of sponges his favourite study. "He was a pioneer," writes his friend, the editor of this volume, "who struck out a new line. As he had begun alone, so he went on alone in his own way, not so much disregarding as seldom or rarely noticing the views of others." It is for this reason that hardly any synonyms will be found in the previous volumes of this work; indeed Dr. Bowerbank was in the habit of not even referring back to his own predescribed species.

However differently the first three volumes of Bowerbank's British Sponges may be regarded, all will agree that this fourth volume is one not only indispensable for the correct understanding of its predecessors, but that the editor's own special additions have made it a work that must be in the hands of every student of this group.

Of the special editorial work we would notice the complete list of species described in all the volumes, with references so complete that it forms as it were a key to the whole. The supplying of recent synonyms, though a most laborious undertaking has been accomplished in a manner to call for the warmest praise. The giving a table of geographical distribution, in which the columns "Abyssal" and "100–500 fathoms" have been partially filled in from Mr. Carter's Report of the Sponges dredged in the *Porcupine* Expedition of 1869 and 1870. This table makes it clear that the Sponge Fauna of many parts of our seas remain almost wholly unexplored, and it is to be much hoped that the very deficiencies exhibited here will have a tendency, among other causes, to induce our younger naturalists to take up so fine a field of research. Mr. Norman, who has a more extended knowledge of the zoology of our coasts than any living naturalist, unhesitatingly asserts "that no other class of animals offers to the student so rich a field for exploration, or one in which he is so likely to meet with so many new and strange forms."

Another important addition to this volume is the catalogue of all works and papers published on the sponges. To the specialist this forms a deeply interesting appendix, and while some few memoirs have escaped the patient research of the author, the pains he had to take to find this out only increases our admiration of the fulness of the list.

Through all the four volumes such frequent mention is made of Mr. Norman's name that it may be not without interest to state that while he gave Dr. Bowerbank all the aid in his power during the progress of the work, placing his collection unreservedly in Dr. Bowerbank's hands, yet that he found himself frequently obliged to dissent from the conclusions of the author. It was hard indeed to convince Dr. Bowerbank against his will, as the writer knows, from a vain attempt carried on through the whole of a winter's evening, to persuade him to see a Cœlenterate structure in what Dr. Bowerbank regarded as the "oscula" of Hyalonema.

It will be useful to specialists in the group of sponges to know that Dr. Bowerbank's collection is now preserved in the British Museum. A brief notice of Dr. Bowerbank is appended to this volume. In calling attention to it the editor writes: "Few naturalists of the present generation will be aware, until they have read it, how much the progress of natural history in Great Britain in years gone by was fostered and furthered by the energy, zeal, and enthusiasm of our late kind friend," and perhaps on reading it some may be inclined to follow in his footsteps only working out the history of our British Sponges on modern methods and with our new lights.

---

[1] "A Monograph of the British Spongidæ," by the late J. S. Bowerbank, LL.D., F.R.S., &c. Edited, with additions, by the Rev. A. M. Norman, M.A., F.L.S. Vol. iv. Supplementary. (London: For the Ray Society, 1882.)

EXPLORATION IN SIAM

A CORRESPONDENT sends us the following:—

Mr. Carl Bock has just returned to England, after a long and difficult journey from Bangkok to the northern frontiers of Siam and Laos. Leaving Bangkok on November 9 last, in a steamer placed at his disposal by the King of Siam, Mr. Bock ascended the Menam as far as Raheng, whence he proceeded overland to Lak'on, which was reached on December 27. Here he was delayed for twelve days by a dispute with the local chiefs, who imposed on him a fine of fifteen rupees for an alleged assault on a Phya or notable; but on January 7 he succeeded in getting away, and reached Chengmai on the 11th. Here he remained, making geological observations till February 2. He found the country fertile, and well cultivated in parts, but the people, as a rule, lazy and superstitious. Leaving here with a caravan of 6 elephants and 20 coolies, he pushed through a hilly, rugged country, to a new settlement at Muang Fang, the site of an ancient city, at one time the capital of Western Laos. Here the few inhabitants were busy clearing the forest and jungle, and Mr. Bock had excellent opportunities of adding to his collection of the fauna of the country. Tigers were abundant and bold, and their raids on the newly-introduced cattle were attributed to the presence of the traveller. Near here he visited the famous cave of Tam-tap-tau, the entrance to which is some 70 or 80 feet up the side of a limestone hill of about 300 feet high, and which is most difficult of access. In the middle of the cavern is a gigantic figure of Buddha, in a reclining posture, thickly gilded, and surrounded with a curious assortment of water jars, cloths, and idols of bronze, wood, and stone, brought there by devotees. Behind this, again, is another figure of Buddha, erect, and in the act of giving a blessing. From Muang Fang Mr. Bock went to Tatong, a small Ngiou village on the River Mekok, which is here only 150 feet across. This stream he followed down to its point of junction with the Mekong, which is twice as wide here as the Menam at Bangkok. Ascending the Mekong, Mr. Bock went to Chen Tsen and Chengmai', where again he had difficulties with the natives, who destroyed nearly all his collection of animals, &c. Hence he returned down the valley of the Mekong, and ultimately reached Bangkok on June 14.

THE COMET

MERIDIAN observations of the comet which was first detected in this country by Mr. Ainslie Common, at Ealing, at 10.45 a.m. on September 17, were made at the Observatory of Coimbra on the 18th, 19th, and 20th, and the following first approximation to the orbit has been deduced from them by Dr. Hind :—

Perihelion passage September 17·1047, M.T. at Greenwich.

	°	′
Longitude of perihelion	271	39·5
,, ascending node	347	44·6
Inclination	37	9·6
Logarithm of perihelion distance	8·09201	

Motion—retrograde.

These elements bear a striking resemblance to those of the great comet of 1843 and 1880, and it hardly admits of a doubt that we have here a return of that body, which will have experienced an amount of diminution of velocity at the perihelion passage on January 27, 1880, sufficient to cause the last revolution to occupy only two years and eight months, and which if experienced to the same extent on the 17th of last month, may bring the comet round again in October 1883.

The comet was perceived in the forenoon of September 18, at many places in the South of France, Spain, Portugal, Italy, &c. From Nice we read :—"Toute la ville a admiré aujourd'hui (September 18), pendant cinq heures, un astre nébuleux brillant vers 3° à l'ouest du soleil." It was seen a day earlier at Reus. M. Jaime Pedro y Ferrier reports : "Le dimanche, 17, à 10h. du matin, les habitans s'arrêtaient avec étonnement sur les places pour admirer la comète visible près du soleil vers 1°·5 à l'ouest. Elle était si brillante qu'on l'apercevait à travers de légers nuages. En l'examinant à l'aide d'une jumelle munie d'un verre noir, on distinguait la queue qui s'allongeait en s'élargissant." The comet was observed at 11 a.m. on September 22, by Prof. Riccò, with the refractor of the Observatory at Palermo : its approximate position at noon was in R.A. 11h. 5m. 39s., and Decl. −1° 51′, according to a communication in the *Giornale di Sicilia* of the 24th, from Prof. Cacciatore, director of the Observatory ; it was not then visible without a telescope, but on the following morning, shortly before sunrise, it was visible to the naked eye, exhibiting a very distinct nucleus, and a tail about 6° in length, leaning towards the south.

A circular from Prof. Krueger, editor of the *Astronomische Nachrichten*, states that the comet was observed at Vienna on September 28, at 17h. 15m. Vienna mean time, in right ascension 161° 28′, and declination −5° 51′. Prof. Auwers observed it at St. Vincent, on his voyage from Hamburg to Punta Arenas, to take part in the observation of the coming transit of Venus. Signor Luciano Toschi found it very distinct to the naked eye at Imola, in Italy, on the morning of the 25th, the apparent length of the tail being equal to the distance between Sirius and κ Orionis, which assigns it an extent of more than 15°.

The Coimbra meridian observations, to which reference has been made, furnish the following places :—

Greenwich M.T.	Right Ascension.	Declination.
	h. m. s	° ′ ″
Sept. 18·01052	11 30 58	+1 22 24
19·00166	11 21 59	+0 24 38
19·99437	11 15 24	−0 25 32

It appears probable that between the time of Mr. Common's observation on the 17th, some hours before the perihelion passage and the meridian observations at Dun Echt and Coimbra on the following day, material perturbation of the elements defining the position of the plane of the orbit may have taken place ; at any rate, the above orbit deviates considerably from the Ealing observations. Assuming that the comet is identical with that discovered by M. Cruls at Rio de Janeiro on the morning of September 12, and that he has obtained a good series of observations of position on the following days, it will be interesting to compare the elements deduced from them with those calculated upon observations made subsequent to the perihelion passage.

From a circular which we have received from the Observatory of Palermo, it appears that Prof. Cacciatore utilised the appearance of the comet in an unwonted manner ; we read : "Mentre l'Italia tutta commuovesi per la grande sciagura toccata ai nostri fratelli delle provincie venete e lombarde, ed in ogni regione constituisconsi con nobile e patriottico slancio comitati di soccorso per venire in aiuto a tanti mali, a secondare il pietoso intento, l'Osservatorio aprirà la sue sale all' alba del 26 alle ore 5 precise, a quei genorosi visitatori, che versando una contribuzione di L. 200 vorran godere del sorprendente spettacolo osservandolo al grande e magnifico nostro Refrattore. Siam certi che la sperimentata filantropia della classe agiata di Palermo non renderà vano l'appello dell' Osservatorio. Per tal guisa l'apparizione di questa cometa, che in altri tempi sarebbe stata segnata come foriera dell' ira divina, e causa delle attuali miserie verrà invece registrata come apparizione benefica alla umanità."

[Since the above was in type, we learn by a communication from Mr. David Gill, dated Royal Observatory, Cape of Good Hope, September 11, that the comet was remarked by Mr. Finlay, the First Assistant, at 5h. a.m. on September 8, or four days before it was found by M. Cruls, at Rio de Janeiro. An exact determination of position on the following morning gave—

Cape M.T.	R.A.	Decl.
h. m. s.	° ′ ″	° ′ ″
Sept. 8, at 17 13 58	144 59 51·4	−0 45 30·0

Observations were made on the morning of discovery, but the comparison star was not identified with certainty.

Prof. Riccò reports marked changes in the spectrum of the comet from day to day, from Palermo observations.

In the *New York Daily Tribune* of September 21, the identity of this comet with that of 1843 and 1880 is pointed out by Prof. Lewis Boss.]

SPECTROSCOPIC WEATHER DISCUSSIONS

TO readers of NATURE who have attended years ago to Mr. Norman Lockyer's most accurate quantitative determinations, by spark spectroscopy, of the relative proportions of silver and gold in certain alloys ; and to Prof. Hartley's similar quantitative analyses more recently by photographed spectra of the strength of different solutions of metallic salts—there need be no difficulty in allowing, that if a meteorological spectroscope can ordinarily show the standard fact of watery vapour being in the atmosphere, it may also, by a little extra nicety and tact in its use, be able to quantify to some extent the proportions of such aërial supply of water-gas at different times, and so to become, in conjunction with the natural philosophy of rainfall, a "rain-band,'' or rain-predicting spectroscope.

There are some persons who will persist in opening the slits of their spectroscopes too wide, and obtaining thereby, when they look at the light of the sky, only a brilliant continuous spectrum of showy colours, or who let the sun, or some strong light glance across the slit, and can then see nothing satisfactorily. But all those others who narrow down the slit almost to extinction, and focus the eyepiece nicely to their own eye, looking from a shaded corner out to a portion of the low, day illumined sky in front of them—all who in fact just do the simply right and proper thing to begin with, have no trouble in seeing, as they extend across the spectrum strip of the daylight, besides the thin solar Fraunhofer lines, and certain hazy lines and bands parallel thereto, and depending on the absorption of the dry gases of our atmosphere—they all, I say, agree and acknowledge that they can also see one, two, or three other bands, which from their places amongst the colours and solar lines, are known to be the spectroscopic imagings of watery vapour. Hence among the recent discussions in the *Times*, the *Scotsman*, and other daily or weekly papers, there was practically no disputation that the spectroscope has the faculty of showing the presence of the otherwise quite invisible watery vapour in the atmosphere. But some of the writers contended that it showed the fact either so faintly, or so capriciously, that the method was of little use even as a hygrometer; could only give deceptive disheartening results in predicting the probable occurrence of rain, and must be looked on merely as one of a number, and by no means the best, of "weather prognostics." Is it worth while, therefore, to pursue the method further?

If with the hope of overcoming the already formed idiosyncratic prejudice of some one human mind, it is not worth while. For there is nothing so easy for an unwilling observer, as to ignore the nicety, and overlook the precision of any quantitative spectroscopic observation; especially when this mode of employing the instrument in our present inquiry has been loudly condemned in public under a depreciating name, which would bring it into the same category as the herd-boy's confident advice to Dean Swift: "Sir, when you see that bull turn his tail to the hedge, then you may be sure it is going to rain."

But we need not after all be offended at the mere name of "prognostic;" for are there not prognostics *and* prognostics in meteorology! What are not the risings and fallings of the wind-compelling barometer itself, but a weather prognostic for those who can interpret them. And even a chart of isobars collected instantaneously from the whole extent of Europe by telegraph, and mapped down in a central office in London, is only another weather prognostic—of a very grand and expensive kind truly; but neither perfect in its forecastings for every part of the country, nor so generally available as could be desired to each private individual therein. I myself, though charged with the meteorological reductions for all Scotland, have never been favoured with a single telegraphic communication of fore-casted weather from the London Office since its establishment. And if I wait, as I did recently, for the isobar map in the *Times*, it arrives here twenty-four hours late of the meteorological events it records; an interval quite long enough to allow of an unwarned-for cyclone having meanwhile entered the country on one side, and left it on the other, after a devastating course across it.

Wherefore a very good apology may surely be set up for many, very many persons in the provinces continuing to observe and speculate on the weather for themselves at their own places of abode, supplementary to any forecasts that may be issued once a day from London. And if such worthy persons do propose to take up the study of the atmospheric water-vapour, or rain-band spectroscope, I do beseech them not to trust to it alone; but endeavour to observe simultaneously with it barometer, thermometer, and wet-bulb hygrometer, not forgetting both wind and cloud. But in that case do you ask, "can the spectroscope give such an observer anything he has not yet already?" It can; for it gives him an instrument far more portable than any other, seeing he can carry it (in its most usual form) literally in his waistcoat pocket; can use it at a moment's notice, when in motion as well as at rest; besides which it gives him such a feeling of certainty and security to know, that even from ever so confined a crib or cabin, with no more than a few cubic feet of peculiar, and for science-purposes vitiated, air about it—he is nobly looking through the whole atmosphere from the surface of the earth right through to space outside, and analysing its condition as to watery vapour (the raw material of rain, as the *Times* happily phrased it) in one instantaneous, integrating glance.

On the other hand, no doubt there is the drawback that no meteorological spectroscope can be used at night, nor in a London fog. It is a daylight instrument, and requires the best part of the daylight too. But such natural light usually lasts long enough to enable anyone to make fifty observations a day, and more too if he be so inclined; though *one* will be usually quite enough in all ordinary weather, if the observer attend to such necessary precautions as these, viz.:—

Observe always low down near the horizon, for atmospheric effects in the spectroscope are there nearly twenty times as strong as in the zenith. Get an opening between clouds if you can to observe through. Prefer that the sun itself shall be angularly distant from your observing direction; and behind a cloud also, if possible, at the instant, so as not to illumine the motes in the air of your neighbourhood with its high altitude light. Especially avoid the minutes of sun-rising or setting, for that act, or rather position, brings certain of the dry gas bands into a short-lived maximum of intensity, without any other signification than that the sun *is* then on the horizon. But good observations may often be taken through falling rain, though not through falling snow, and also between the earth and the under sides of the clouds, if they entirely shut out all view of the air of the heavens beyond them.

Sometimes dense coal smoke, or thick low fogs and mist may prevent the observer obtaining his usual spectroscopic shot at a very low angle of altitude; and if he then points the instrument higher, the telluric rain-band is necessarily weaker. How then is he to eliminate that mere accidental, though most forcible, effect? Simply by making his notation of the strength of the rain-band not absolute or solitary, but differential in terms of another band which is not connected with watery vapour. And herein he will find himself much assisted by the arrangements of nature, or thus:—

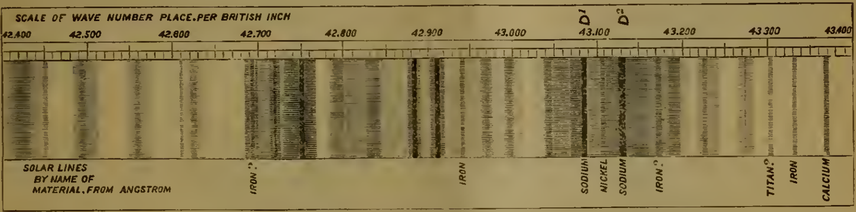
The strongest of the water-vapour or rain bands in the spectroscope is on the red side of the solar D line, and apparently attached to it; while at a very little distance, removed away on the yellow side occurs a dry gas band, called at home, in a lady's journal, the "low-sun band." But throughout the greater part of the day forming only a faint, constant shade, in terms of which the rain-band may be entered; and as they are both affected in the same degree by merely being looked at in a high or low sky, the proportion between the two, which is all that we require for the intended quantification of watery vapour, remains the same.

Again, before deciding on what conclusion, as touching rainfall, is to be drawn from any particular degree of darkness of the said water-vapour band, let the observer consider the temperature of the air at the time. Run down the columns of Mr. Glaisher's invaluable tables for reducing hygrometric observations, and obtain thereby a vivid idea of how rapidly the power of the air to hold moisture in invisible suspension increases with the temperature; and remember that it is not until the quantity of watery vapour accumulates to a still greater extent than what air of such temperature can assimilate, that there is spare material enough for producing rainfall. Hence, while in Scotland a rain-band of intensity marked 2 usually produces a little rain, and 3 produces much, yet in Lisbon during the same months the so-called rain-band, but really only water-vapour band, may mark 4, and yet no rain fall. But with 5 or 6, the temperature remaining the same, down rain will come even in that usually arid country.

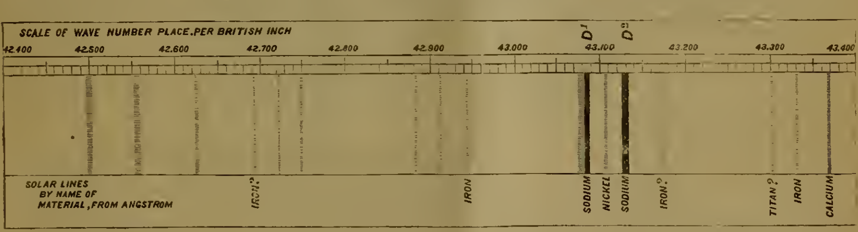
Again, whatever number of supernumerary observations any person may take, when his enthusiasm-fit is upon him, he should never neglect his usual, regular observation at a fixed hour, say 9 a.m. For if the wet-bulb depression goes through a diurnal rise and fall according to the hour, something of the same kind may be looked for in the strength of the spectral water-vapour band; though fortunately it is not so very marked a feature there, because the upper strata of the atmosphere are more constant in their composition from hour to hour, than its lower beds in contact with earth and water.

But why should I go on wearying readers of NATURE with these little details, when they can far better find out such things for themselves, and often realise improvements therein. See how well Mr. Rand Capron has mastered the subject, in his "Plea for the Rain-band" in Mr. Symon's Meteorological Magazine. How acutely Colonel Donnelly appears to have detected in the second water-vapour band of the spectrum, viz. that near the solar C line (a darker part of the spectrum than that occupied by the band near D, and therefore more difficult to observe), an indicator of a different order of precipitation from the atmosphere than ordinary rainfall. And again I trust to be excused for mentioning here that my friend, Mr. T. Glazebrook Rylands, has now accumulated an immense deal of experience as to the advantage of supplementing spectroscopic rain-band observations with a polariscope equally portable.

At present, when experimenting for further advance, I rather prefer the spectroscope alone, but of greatly increased size and power; and it was not until very lately that I fully experienced what can be done in this way upon merely the faint light of the sky near the northern horizon, a region seldom seen here without more or less clouds and much manufacturer's coal-smoke, yet forming a better constant of daylight than if I had attempted to look southward into the neighbourhood of the sun.



The Water-Vapour band on the Red side of D^1 and D^2; as seen in the faintly illuminated North-Western sky at 5° above the horizon, from Royal Terrace, Edinburgh, through the average of August 1882, at 10 a.m. each morning, with a powerful spectroscope. Temp. = 62°·0, depression of wet bulb = 3°·0.



The same as seen on September 4, 1882, on the eve of a whole week of very dry weather; temp. = 55°·0, depression of wet bulb = 5°·2.

On direct sunlight, whenever it can so very rarely in this country be enjoyed, of course almost any spectroscope will show multitudes of lines, and even split up telluric bands into many fine lines; but to see a large spectroscope accomplish nearly the same fact on merely low sky illumination, gave me a new idea of the discriminating powers of this marvellous modern apparatus, and impressed me with the positive duty of trying to use it quantitatively, as well as qualitatively. I append, therefore, a map of the lines and bands of the chief "rain-band," so called, of the ordinary spectroscope, but now as seen in the larger instrument through the average of last August; and again, for a contrast, as it was seen on one particular day, September 4, when a week of the driest and coldest weather of the season was about to begin.

The hygrometer readings taken elsewhere conformed pretty well to these descriptions; but in their whole variations from 2° or 3° for the earlier, and 6° for the latter time, there was nothing to call up such intense interest as the spectroscope's astounding fact of the almost entire sweeping away on September 4 of the many and rich details of the previous month, in so far, of course, as they were water-vapour spectral details. Nature herself does therefore offer in the way of groundwork for rainfall forecasting in the spectroscope, so large an amount of material, that I do trust no one will undervalue it, until they have had practice, with an equally powerful instrument with that I have just alluded to. Its main features are, that the object-glasses of both collimator and telescope are 2·25 inches in diameter; each of its two prisms is 7 inches long and 3·5 inches square at the end, and contains bisulphide of carbon at a refracting angle of 104°, while the telescope's magnifying power is 15°. The definition of the prisms had been previously tested on bright hydrogen lines in a dark field, and found to be admirably perfect, much to the credit of their maker, Mr. Adam Hilger.

Take it all in all, nothing less powerful should be employed in critical researches; and as these prisms give together a dispersion of 24° between A and H, the pictures they offer, with the further assistance of the telescope, have a physiognomy comparable at once with either Angstrom's or Kirchhoff's standard solar spectrum maps, so universally respected over the whole world.

C. Piazzi Smyth
Astronomer Royal for Scotland

ELECTRIC NAVIGATION

THE idea of propelling a boat through water by the motive power of electricity is no new one. The invention of the electromagnet showed the power of an electric current to produce a mechanical force. It was no very difficult matter, therefore, for the electricians of fifty years ago to utilise the force of the electromagnet to drive small electromagnetic engines; and from the small beginnings of Dal Negro, Henry, Ritchie, and Page, grew up a group of electric motors which only awaited a cheap production of electric currents to become valuable labour-saving appliances. Nor was it a very long stride to foresee that if a sufficiently powerful battery could be accommodated on board a boat, it might be possible to propel a vessel with electromagnetic engines drawing their supply of currents from the batteries. This suggestion—one of the earliest, indeed, of the many applications of the electromagnet—was made by Prof. Jacobi of St. Petersburg, who, in 1838, constructed an electric boat. Fig. 1, which we here reproduce from Hessler's "Lehrbuch der Technischen Physik," represents the rude electro-magnetic motor or engine, which Jacobi devised for the driving of his boat. Two series of electro-magnets of horse-shoe form were fixed upon substantial wooden frames, and between them, centred upon a shaft which was connected to the paddle-wheels, rotated a third frame, carrying a set of straight electro-magnets. By means of a commutator made of notched copper wheels, which changed the direction of the current at appropriate intervals, the moving electro-magnets were first attracted towards the opposing poles, and then, as they neared them, were caused to be repelled past, so providing a means of keeping up a continuous rotation. This machine was worked at first by a Daniell's battery of 320 couples, containing plates of zinc and copper, 36 square inches each, and excited by a charge of sulphuric acid and sulphate of copper. The speed attained with this battery did not reach so much as 1¼ miles per hour. But in the following year, 1839, the improvement was made of substituting 64 Grove's cells, in each of which the platinum plates were 36 square inches in area. The boat, which was about 28 feet long, 7½ broad, and not quite 3 feet in depth, was propelled, with a convoy of fourteen persons, along the River Neva, at a speed of 2¼ (English) miles per hour.

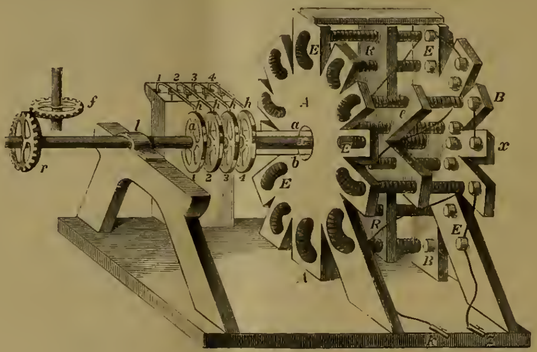


Fig. 1.—The Engine of Jacobi's Electric Boat, 1838.

A second attempt at electric navigation was made on a much smaller scale about two years ago by M. G. Trouvé, the well-known manufacturer of electric apparatus, of Paris, who constructed an electric skiff, in which he placed one of his small and compact motors, and drove it by means of a battery of Planté's accumulators, previously charged.

The Neva and the Seine having been respectively the scenes of the first and second efforts at electric navigation, it was fitting that the Thames should be the scene of the third, and most recent one.

The electric launch *Electricity*, which made its trial trip on Thursday, September 28, 1882, on the waters of the Thames, is certainly a great advance upon that which had been previously attained. This boat, the arrangements of which have been designed and carried out by Mr. A. Reckenzaun, C.E., mechanical engineer to the Electrical Power Storage Company of Millwall, is of iron, and is a trifle less in length than the wooden boat which Jacobi propelled. She will carry twelve persons, though at the trial trip but four were on board. The screw-propeller is calculated to run at 350 revolutions per minute, the two Siemens' motors running at 950 revolutions. The accumulators, which weigh 1¼ tons, are calculated to supply the necessary current for seven or eight hours of continuous work.

Having been one of a privileged party of four, the first ever propelled upon the waters of the river Thames by the motive power of electricity, I think some details of this latest departure in the applications of electric science may be of interest. At half-past 3 on the afternoon of Sept. 28 I found myself on board the little vessel *Electricity*, lying at her moorings off the wharf of the works of the Electrical Power Storage Company at Millwall. Save for the absence of steam and steam machinery, the little craft would have been appropriately called a steam launch.

She is 25 feet in length, and about 5 feet in the beam, drawing about 2 feet of water, and fitted with a 22-inch propeller screw. On board were stowed away under the flooring and seats, fore and aft, 45 mysterious boxes, each a cube of about 10 inches in dimensions. These boxes were nothing else than electric accumulators of the latest type as devised by Messrs. Sellon and Volckmar, being a modification of the well-known Planté accumulator. Fully charged with electricity by wires leading from the dynamos or generators in the works, they were calculated to supply power for six hours at the rate of four horse-power. These storage cells were placed in electrical connection with two Siemens' dynamos of the size known as D 3, furnished with proper reversing-gear and regulators, to serve as engines to drive the screw propeller. Either or both of these motors could be "switched" into circuit at will. In charge of the electric engines was Mr. Gustave Phillipart, jun., who has been associated with Mr. Volckmar in the fitting up of the electric launch. Mr. Volckmar himself and an engineer completed, with the writer, the quartette who made the trial trip. After a few minutes' run down the river and a trial of the powers of the boat, to go forward, slacken, or go astern at will, her head was turned Citywards, and we sped—I cannot say steamed—silently along the southern shore, running about eight knots an hour against the tide. At 4.37 London Bridge was reached, where the head of the launch was put about, while a long line of onlookers from the parapets surveyed the strange craft that without steam or visible power—without even a visible steersman—made its way against wind and tide. Slipping down the ebb the wharf at Millwall was gained at 5.1, thus in 24 minutes terminating the trial trip of the *Electricity*. For the benefit of electricians I may add that the total electromotive force of the accumulators was 96 volts, and that during the whole of the long run the current through each machine was steadily maintained at 24 amperes. Calculations show that this corresponds to an expenditure of electric energy at the rate of 3 1·11 horse-power.

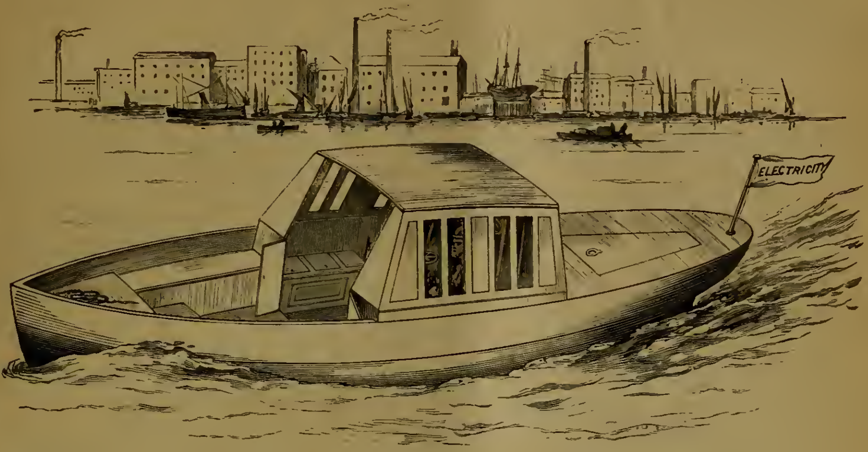


FIG. 2.—The Electric Launch.

Fig. 2 gives a general view of the electric launch afloat. The arrangements of the driving machinery are shown in Fig. 3, which is a section of the boat, taken amidships. The accumulators, B B, are stowed as low as possible, and form an admirable ballast. The two Siemens' dynamos are connected by belts with an overhead countershaft, and arranged with a friction-clutch, by means of which one dynamo can be thrown in or out of gear at will. From the countershaft a third belt passes down to a pulley on the axis of the screw. Each of the engines is provided with two pairs of brushes at the commutators, one pair having a lead forward, the other backward, enabling the motion to be reversed by raising or lowering one or other pair of brushes. Of the practical success

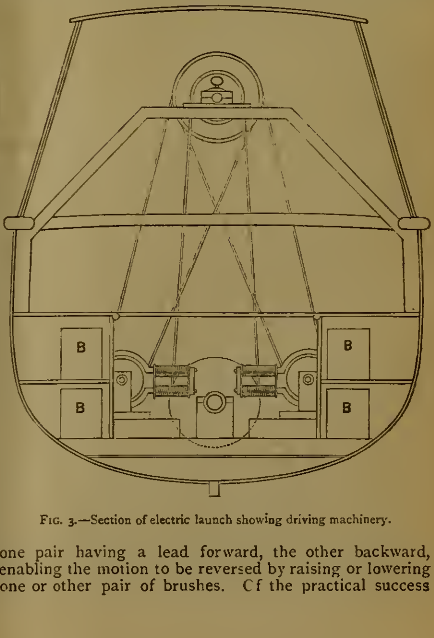


FIG. 3.—Section of electric launch showing driving machinery.

of this little craft there can be no question. Of its economy it is premature to speak. It is, however, greatly in favour of electric navigation, that such machinery may be both lighter and more compact than that of steam-engines of corresponding power; that the noise and vibration is very greatly reduced; and that, lastly, there is a complete absence of the nuisance of smoke, which appears to be inseparable from steam navigation.

SILVANUS P. THOMPSON

NOTES

AT the sitting of October 2 of the Academy of Sciences, M. Dumas delivered an address on his friend, Prof. Wœhler, of Göttingen, one of the eight Foreign Associates of the French Academy, whose death had been announced by telegram. He also gave the list of the eight missions sent by the French Government to observe the transit of Venus. The total expense charged against the national exchequer is estimated at 1,200,000 francs.

PROF. MOSELEY, who is conducting the researches which the Cardiff Naturalists' Society is making with regard to the fisheries in the sea beyond Lundy Island and the mouth of the Bristol Channel, has been successful in obtaining a specimen of "Arnoglossus Lophotes," a Pleuronectid with the anterior rays of the dorsal fin curiously elongated, hitherto known only from two dried skins in the Couch collection, the locality of which was uncertain. This specimen, which is now in the British Museum, establishes the validity of Dr. Günther's classification of this fish as a distinct British species.

AN excavation for geological purposes was made in the New Forest during the last fortnight of September by Mr. J. W. Elwes of Otterbourn, and Mr. T. W. Shore of Southampton, who obtained special permission for this purpose. A considerable area of the Brockenhurst bed was exposed by the removal of about twelve feet of overlying strata near the railway cutting which yielded such interesting specimens forty years ago. More than a thousand good specimens were obtained on the present occasion, comprising seventy species of molluscs and some corals. The work was directed by Mr. Keeping, of the Woodwardian Museum, Cambridge.

AMONG the special features of the Munich Electrical Exhibition is a telephone transmitting thither pieces of music performed at Oberammergau, which is about 63 miles distant; also a giant telephone, which transmits concert pieces performed in the English Café, so as to be audible to the whole of an audience in a large hall at the Palace. A special interest also attaches to the transmission of power by a single wire from the coal-mines of Miesbach, about 37 miles distant, as the possibility of utilising the heat of coal at a distance without transport of the coal is concerned.

IT has been ascertained that the first experiment with air balloons was made by Montgolfier the elder, at Avignon, when he was a resident in this city in the month of November, 1782. He sent up in his room a parallelopiped of canvas, of which the measurement was 40 cubic feet, and which had been heated by burning paper inside. The room is still in existence, in a house in front of which the Municipality have placed a commemorative inscription. The window fronting the street is adorned with an iron balcony, at both ends of which a small gilt balloon has been placed. The anniversary will be celebrated in Paris by a banquet given by the Academy of Aërostation, and very probably a local celebration will take place in Avignon.

ACTIVE preparations are being made for an electrical and gas exhibition, to be opened at the Crystal Palace on October 24.

A WORK on South African Butterflies—"A Monograph of the Extra-Tropical Species," by Mr. Roland Trimen—is announced by Messrs. Trübner. It will be much more than a new edition of the author's former work; the plates will be entirely new.

WE are asked to state that an article by Dr. James Croll, F.R.S., entitled "Evolution by Force Impossible; a New Argument for Theism," written before his recent illness, will shortly appear in one of the quarterlies.

UNDER the title of "Boats of all Nations, drawn from Nature," Mr. G. H. Andrews proposes to publish a work in large folio, illustrative and descriptive of the origin, history, and peculiar characteristics of the smaller craft of Great Britain, Norway, Denmark, Hanover, Holland, Belgium, Spain, Italy, Greece, Turkey, Asia Minor, and North America. The work will be illustrated by thirty facsimile copies of the original drawings and many sketches of details. The interest and utility of such a work are evident, and to judge from the specimen before us Mr. Andrews is likely to do the subject justice.

IN the *Revista* da Sociedade de Instrucção do Porto, Prof. Oliveira regularly continues his Catalogue of Portuguese Insects; in the current number it is carried to the end of *Bembidium* in the *Coleoptera*. In this same number is what appears to be a valuable contribution to botanical bibliography, viz. a "Review of the Hepaticological Works of the European Flora published since the appearance of the Synopsis Hepaticarum," printed in English. The author is P. Stephani, who dates from Leipzig.

IN *Natural History Notes*, a series of articles on "Plant Symbolism, as connected with the Early History of Mankind," by S. Marshall, F.R.Hist.S., is being published.

WE have received from the Bristol Museum and Library the Syllabus of the usual course of lectures on scientific and literary subjects, to be delivered in the Lecture Theatre, on Tuesday evenings during the winter. It is as well arranged as in previous years.

IN reference to our correspondence on the aurora we may say that Mr. E. J. Stone, director of the Radcliffe Observatory at Oxford, telegraphed to the *Times* on Monday night:—"An aurora has been visible this evening, extending over a large portion of the sky. It appeared in bright patches towards the south, which were continually changing. The spectrum was linear."

AT her country house in Sussex, Lady Dorothy Nevill, so well known for her active interest in natural history, has two pairs of choughs which are allowed full liberty. They fly about the grounds, but are quite tame, and come to a window or into a room to be fed. One pair has taken to a small tower on the roof of the house as a roosting place, and prevents the other pair, which has to roost in a shed, from approaching it. This year the pair built a nest on the top of the wall of the tower in a corner under the roof and laid eggs, but unfortunately failed to hatch them. Although the chough is familiarly known as a bird readily tamed, it has apparently not been observed to nest in the domestic condition before. It is hoped the birds may rear a brood next year in the tower. The nest they made is an extremely neat one, deep and secure, and lined with hair and wool. It is curious that the one pair should drive the other away from the tower, where there is plenty of room for several nests. The pairs keep apart all day, and seem to lose, when thus domesticated, their natural gregarious instincts.

SHOCKS of earthquake occurred at St. Louis and parts of Illinois and Indiana on September 27.

ADVICES from Montevideo announce the arrival there of the French Venus Transit expedition. Part will observe the transit at Carmen de Patagones, and another party will go to Santa Cruz. The Brazilian astronomers will observe the transit of Venus from four stations, viz. one at Rio Janeiro, one at Pernambuco, one in the West Indies, and one about Cape Horn.

According to the Report of the Government Central Museum at Madras for the year 1881-82, by Surgeon-Major Bidie, the number of visitors was 211,246, and therefore 37,348 in excess of the attendance in the previous year, and 23,051 above the average of the preceding five years. Of the visitors, 40·17 per cent. were women and girls, and 59·82 men and boys; the corresponding rates in 1880-81 having been 39·36 and 60·63. There was thus a slight increase in the number of female visitors on the days on which the Museum was open to all classes. As in former years, the building was cleared of males, and reserved exclusively for native ladies on the afternoon of the first Saturday of each month, but on these occasions the average daily attendance was but 37 against 114 in the previous year. It is difficult to explain this decline, in the face of the anxiety expressed by native gentlemen for extended means of intellectual culture and amusement for the ladies of their families. In some cases it was evidently considered undignified to visit the Museum when other ladies were also allowed to attend, as I had various importunate requests to have the building specially opened for a single family on Sunday, which I was obliged to refuse. All visitors before leaving the lobby are required to write their names in the door-book, or if unable to sign, their numbers are counted During the year 26·45 per cent. of the total visitors, against 27·77 per cent. in 1880-81, entered their names in the book, and 73·54 per cent. professed their inability to write. In looking at these figures as a gauge of popular education, it has to be pointed out that in many cases one member of a family or party signs for the whole, and that a small proportion consists of children too young too be able to write. As stated last year, a large number of the more intelligent ordinary visitors pick up scraps of useful knowledge as they pass through the rooms, and may come for the express purpose of acquiring information. As a whole the Museum is perhaps the most popular public institution in Madras, and there can be no doubt that its popularity and utility will increase as the education of the lower classes advance. Tables B and C in appendix show the monthly attendance and other results as regards visitors. The report contains a list of the numerous additions in all departments, made to the Museum during the year.

The mucous membrane of the larynx is known to be extremely sensitive, so that, when touched, violent reflex movements are produced, the glottis contracting spasmodically, and the whole larynx rising forcibly. M. Brown Séquard has lately made the interesting observation (*Comptes Rendus*) that complete local anæsthesia may be obtained in the larynx by directing on the upper part of that organ (through an incision at the back of the animal's mouth), a rapid current of carbonic acid, for fifteen seconds to two or three minutes. It becomes possible to introduce a tube and even a finger (in the case of a large dog) into the cavity of the larynx, and to turn it about without producing reaction. Chloroform vapour gives the same effect, but the other gas is preferred. There is some irritation at the outset. The local anæsthesia, which is accompanied by incomplete general anæsthesia, lasts several minutes (two to eight) after stopping the current. The experiment was repeated several times, at intervals, on the same animal, and no evil results were apparent. M. Brown Séquard proposes to experiment on the human subject by introducing carbonic acid into the larynx by the mouth or nostrils.

It has been recently observed by Prof. Feichtinger of Munich (*Polyt. Jour.*) that of a number of different kinds of writing and printing paper examined, all those kinds that had been sized with resin had a more or less acid reaction, while this property was never met with in paper with animal sizing. (Paper can be easily tested in this respect by placing moistened blue litmus paper between folds of it.) The acid reaction was found to be due to free sulphuric acid, and it is thought probable that in the use of alum, in resin-sizing, free sulphuric acid is formed in the mass of paper, and remains there. The durability of a paper must undoubtedly be injured by presence of free sulphuric acid. Some of the papers with a strong acid reaction were kept fourteen days in a water bath, which was heated only by day, and they became quite brittle. The acid also acts prejudicially by gradually destroying the black colour of writing on the paper, especially in damp places.

M. Gauthier Villars has just published a translation of M. Cully's "Handbook of Practical Telegraphy," by Mr. Henry Berger and Paul Bardonnant, of the French Postal Telegraphic Service. This translation contains some useful supplements on the peculiarities of French telegraphy and the pneumatical service as established in Paris.

We have received the *Proceedings* of the Norwich Geological Society for 1880-81, together with the anniversary address of the president, Mr. J. H. Blake. The former contains several good papers on local geology.

A useful "Table Générale et Systematique des Matières" contained in the first fifty-six volumes (1829-81) of the *Bulletin* of the Imperial Society of Naturalists of Moscow, has been prepared by M. E. Ballion, and published at Moscow by Archipoff and Co.

Mr. R. Anderson is preparing for publication the papers read by him at the British Association, on Lightning Conductors.

There are now 375 naphtha wells on the Apsheron peninsula of the Caspian, their aggregate yield being 9,600,000 cwts. per year.

The additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, presented by Mr. A. Fitch; two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, presented by Mr. L. Bennett; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. Paris; a Nisnas Monkey (*Cercopithecus pyrrhonotus* ♂) from Nubia, presented by Mrs. F. Dixon; a Glutton (*Gulo luscus*) from Russia, presented by General Astashoff; a Hairy Armadillo (*Dasypus villosus*) from South America, presented by Mr. F. R. Warre; four Barbary Mice (*Mus barbarus*) from Barbary, presented by M. Pichot; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mrs. Attenborough; two Common Waxbills (*Estrelda cinerea*) from West Africa, presented by Miss E. à Court; six Florida Tortoises (*Testudo polyphemus*) from Florida, presented by Mr. G. E. Manigault; eight —— Lemurs (sp. inc.) from Madagascar, deposited; two Malabar Squirrels (*Sciurus maximus*) from South India, a Violaceus Plantain Cutter (*Musophaga violacea*) from West Africa, a Greenland Falcon (*Falco candicans*) from Greenland, a Razor-billed Curassow (*Mitua tuberosa*), a Crested Curassow (*Crax alector*) from Guiana, three Elliot's Pheasants (*Phasianus ellioti* ♂ ♀ ♀) from Ningpo, purchased; a Black-faced Spider Monkey (*Ateles ater*) from East Peru, an Eland (*Oreas canna* ♀) from South Africa, received on approval.

BIOLOGICAL NOTES

On a New Genus of Cryptophyceæ.—A freshwater algæ recently discovered in Brazil, belonging to the group of the Stigonemeæ, has been described by Drs. E. Bornet and A. Grunow, under the name of *Mazæa rivularioides*. This algæ, remarkable in various ways, externally resembles *Rivularia plicata*, Harv., its fronds rounded, more or less irregularly knobby, attain to a diameter of about twenty-five millimetres, at first solid and somewhat firm; later they become hollow and soft. The colour of moistened specimens is of a sombre green, inclining to olive. The trichomes, immersed in a homogenous colourless jelly, spread themselves around a central space; they increase towards the periphery, and become lost in the interior. These trichomes give origin to branches, either scattered or unilateral, which elevate themselves to the one height and to heterocysts either sessile on the side of the articulations, or borne on a pedicel of one to three cells; intercalary heterocysts were not observed. The heterocysts were oblong in form, easily to be distinguished from the ordinary articulations by their size, and above all, by the nature of their contents, which is more homogeneous; when old, they assume a yellowish tint; the chloro-iodide of zinc solution colours them purple. When an articulation forms a heterocyst or a branch, it first forms a lateral enlargement, which is very early isolated. This new cell may at once change into a heterocyst, and then it will be directly applied to the side of the articulation, as are the heterocysts of Capsosira and those on the large branches of Stigonema, or it may be divided once or twice before the formation of the heterocyst, which will be then pedicellated, or it may even form the cell from which a branch may arise. The branches, like the heterocysts, are not uniformly arranged along the length of the filament. At certain intervals they become closer and they become level at the same height. Some remain simple, others ramify, none terminate in a hair. No distinct trace of a sheath was observed around any of the younger portions of the trichomes, but at the base the articulations are sometimes surrounded with a somewhat thick envelope. None of the specimens (not very numerous) examined showed the least trace of spores or homogones. Two characters of this genus are particularly interesting its Rivulariaceous appearance, and its pedicellated heterocysts. This latter peculiarity, which to this time was not yet met with among the Cryptophyceæ, indicates in Mazæa a degree of specialisation of the parts of the trichome more eminent than that in any other genus of Stigonemaceæ, in fact represents the highest development in the group. Now that in this form and in *Capsesira brebissonii* = *Stigonema zonotrichioides*, Nordst, Stigonemaceæ have Rivularioid representatives; it may be noted that Scytonemaceæ is the only tribe in which this type is wanting. The new species is beautifully figured after drawings by Bornet (*Bull. de la Soc. Bot. de France*, tome xxviii.).

SEED LEAVES OF BURSERA.—The cotyledons of the natural family Burseraceæ are described by Bentham and Hooker ("Genera Plantarum," vol. i. p. 321) as often membranous contortuplicate, rarely solid and plano-convex, and in the genus Bursera itself they are diagnosed in addition as "interdum trifidæ, in una specie hippocrepiformes." Prof. Asa Gray, (*Proc. Amer. Acad. Arts and Sciences*, vol. xvii. p. 230) mentions that specimens of *Bursera microphylla* were collected at Cape San Lucas, Lower California,[1] in fruit, and also in Sonora in flower. It appears to have all the characters of Bursera except that the ovules are solitary in the cells. Recently Messrs. Parish have collected it in Arizona, near Maricopa, in fruit, and from some of the seeds sent by them to the Botanic Gardens at Harvard University, young plants have been raised. The cotyledons are very peculiar, and are in the woodcut represented a little larger than life; they are biternately dissected into narrow linear lobes. The second pair are simpler, the secondary lobes being fewer and short, the next succeeding are pinnately parted into seven leaflets, passing toward the adult form of leaf, which is pinnate with numerous very small leaflets on an interruptedly margined rachis.

AFFINITIES OF THE BOWER BIRDS.—The very interesting group of birds known as the Bower Birds is regarded by Mr. Elliott as connected with the Birds of Paradise, and in this view Count Salvadori agrees. Mr. Sharpe in his "Catalogue of Birds" takes a different view, but in a paper on the Ornithology of New Guinea, just published (*Journal Linnean Society*, vol. xvi. p. 443, July 31, 1882), he acknowledges that he has now been convinced that the views of Elliot and Salvadori are right, and states that the following note, by Mr. Goldie, of the habits of *Diphyllodes chrysoptera*, Gould, which is a true Bird of Paradise, has in great measure been the cause of this change of view. Mr. Goldie writes: "The bird is found in very rough and thick scrubby country, at the head of gullies or on steep sidings, where he clears a space of ground, about seven feet by four, by stripping all the leaves and twigs off the bushes, leaving only the heavier branches. The ground is cleared of all leaves and is quite bare, and this seems to be his playground; in it he dances and flutters about as if at play. The natives know his call and attract him, but as soon as he perceives any one, away he flies, and can be tempted no more at that time. When not about the nest he is to be found in exceedingly high trees. His food consists of seeds." These habits are curiously like those of the Bower Birds, and show that Birds of Paradise can flirt on the earth as well as among the tree tops.

GEOGRAPHICAL NOTES

DR. MIKLUCHO-MACLAY has arrived at St. Petersburg after a sojourn of twelve years on New Guinea and neighbouring islands. It is stated that the eminent naturalist and explorer intends to remain only six weeks in Russia, when he will return to Sydney, where, as we have already intimated, he has been the means of founding a zoological station.

DR. EMIL HOLUB is arranging to set out for his new expedition to South Africa in April 1883. He proposes to spend from six to eight months in Cape Colony and in the Bechuana country respectively; after which he intends to penetrate as far north of the Zambesi as possible. Dr. Holub will devote his attention to observations and collections in zoology, botany, geology, and ethnography.

MR. H. K. BANCROFT, author of the well-known work on the Native Races of the Pacific States, is about to begin the issue of a new work in 25 large vols., giving the History of the Pacific States of North America. It is an enormous undertaking. Trübner and Co. are the publishers.

AN expedition under Lieut. Andreyew, sent out by the Russian Geographical Society, has safely reached Novaya Zemlya, where it will pass the winter. Besides Lieut. Andreyew there is a scientific staff and five sailors.

MR. STANFORD has issued the second instalment of Mr. Ravenstein's large map of Eastern Equatorial Africa. It contains sheets 12 to 18, with the exception of sheet 15. These sheets combine all the region around Lake Tanganyika, a large part of the course of the Lualuba, the Mwvtan Nzige, much of the Victoria Nyanza and the country around it, and the wide district lying between the north end of Nyassa, the south of Tanganyika, and the coast to Zanzibar. The routes of all travellers are given, the authorities for every leading feature stated, and the information laid down so detailed that the map serves all the purposes of a special treatise on African geography. The map is a credit to Mr. Ravenstein as well as to the enterprise of the Geographical Society, at whose expense it is being constructed.

THE *Deutsche Rundschau für Geographie und Statistik* has entered upon its fifth year, and appears to be a good example of a popular journal of geography. In the first number of the new volume we find an article on the Ethnography of Central Asia, by Dr. Ujfalvy; an article on Egypt, by Herr Schweiger-Lerchenfeld; an illustrated paper on Land and People in Sikkim; papers on the Transit of Venus and the Sun's Parallax, by Dr. Haletchek; on the Hydrography of Central Africa and the interesting problem of the Welle, by Dr. Chavanne; on

Baron von Richthofen (one of a series on Eminent Geographers) besides several other papers, and notes on political geography and statistics. The *Rundschau* is edited by Prof. Umlauft, and published by Hartleben of Vienna.

THE steamer *Louise* returned to Hammerfest on October 1 from the southern part of the Sea of Kara. The Captain reports that, owing to the prevalence of a hard frost and the consequent accumulation of ice, vessels are unable to pass. The *Louise* left the Danish exploring vessels, *Varna* and *Djimpha*, on September 22, ice-bound, at a point eighty miles to the east of the island of Waigatz. All was well on board, and hopes were entertained that they would shortly be set free.

IN the October number of the *Proceedings* of the Royal Geographical Society, the leading papers are on the Cameroons District, West Africa, by Mr. George Grenfell; and on the Coast Lands and some Rivers and Ports of Mozambique, by Mr. H. E. O'Neill, H.B.M. Consul, Mozambique. From the Notes we learn that Mr. H. Whiteley, who has devoted himself for many years to natural history pursuits in the interior of British Guiana, has just returned to England. He resided for upwards of a year among the Indians in the neighbourhood of the famous Mount Roraima, of which in its many aspects he made a numerous series of drawings. The number, we may say, contains a full report of the important paper on the Deserts of Africa and Asia, read by M. Tchihatcheff at the Southampton meeting of the British Association.

PELAGIC LIFE[1]

AS used technically by naturalists, the term "Pelagic" applied to living things denotes those animals and plants which inhabit the surface waters of the seas and oceans. Just as the land surfaces, the sea shores, and the deep ocean beds are each tenanted by assemblages of organisms specially adapted to the conditions of existence there occurring, so the surface waters of the oceans are inhabited by a characteristic fauna and flora. The special modifications in structure which the members composing this fauna and flora exhibit as adapting them to their peculiar environment are of a most interesting and remarkable character: and it is concerning the nature of the Pelagic fauna and flora, the mutual relations between the two, the strange forms which Pelagic animals assume, their curious habits of life, their zoological and geological importance, that the present lecture on Pelagic Life will consist. I have spoken of pelagic life as belonging to the surface waters of the oceans because it is in the superficial strata in which it appears to be most fully developed; but, as we shall see in the sequel, it is impossible as yet to limit definitely the range of pelagic forms in depth, and we shall even have to refer to some connections of the fauna of the deep ocean bottom with that of the surface.

Pelagic life then includes the inhabitants of the whole ocean waters, excluding those belonging to the bottom and shores; that is to say, the inhabitants of an area equal to nearly three-quarters of the surface of the globe. And it may tend to enhance our appreciation at the outset of the importance of the pelagic fauna if we reflect that in point of numbers pelagic animals probably far exceed all others existing. The extraordinary abundance of life, as seen at the surface of the ocean under certain circumstances, when the water is often discoloured for miles and its surface strata absolutely filled with small animals, has often been described by voyagers, but can never be fully realised till it is actually witnessed.

The existence of pelagic animals at all is directly dependent on that of pelagic plants. No animal life can exist without vegetable food as a basis, and the first living substance which came into existence must have been capable of constructing protein for itself from inorganic sources, and been physiologically a plant. Now, in many regions the sea-surface teems with vegetable life. In the Polar waters diatoms swarm, sometimes occurring so abundantly that they render the water thick like soup, and being washed up on the ice in the Antarctic regions, colour it brown, as Sir Joseph Hooker showed. When a fine net is towed overboard amongst them, they fill it with a jelly-like mass that, when squeezed in the hand, leaves behind their skeletons, a mass of fine silica like cotton wool. In the temperate and warmer seas, diatoms, though still present, are scarcer, and their place is taken by other simple minute algæ, mainly Oscillatoriæ. As we passed through the Arafura Sea between Australia and New Guinea in the *Challenger* Expedition, the whole sea for several days' voyage was discoloured far and wide by such algæ, and smelt like a reedy pond; and in the Atlantic we passed for days through water full of minute algæ (*Trichodemium*) gleaming in the water like particles of mica. From these fine algæ the simpler animals, on which the higher animal forms subsist, derive their food. No doubt the food-supply is largely supplemented by organic *débris* of all kinds drifted from shores, and by floating sea-weeds, certain species of which, like the gulf-weed, grow in a pelagic condition. Coccospheres and Rhabdospheres may very possibly be of vegetable nature, and contribute to the pelagic stock of food, together perhaps with some of the Cilio-flagellata, such as Ceratium,[1] which may prove also to be physiologically vegetable. However, in many parts of the ocean vegetable organisms are not markedly abundant, and it had always seemed to me that the ultimately pelagic food supply was scarcely as abundant as it should be to account for the vast extent of pelagic fauna, until the recent establishment by Dr. Karl Brandt, of the existence of the curious condition of mutual relations of certain animals and plants known as symbiosis.

It is found that amongst the tissues of certain animals there are constantly imbedded quantities of unicellular algæ. These algæ are not to be regarded as parasites, but a relation of mutual benefit exists between them and the animal with which they are associated; they are nourished by the waste products of the animal, whilst the animal thrives on the compounds elaborated by them and the oxygen they set free. Such an association of mutual benefit is termed symbiosis, and it was in the case of some of the most abundant of pelagic animals, the Radiolarians, that the true nature of the algæ in question was first discovered by Cienkowsky. I shall throw on the screen a figure of one of these Radiolarians Collozoum inerme. It consists of a rounded mass of jelly traversed by fine radiating pseudopodia with a central spherical sac or capsule, and in the interior of that a large oil globule. One function of the oil globule apparently is to float the animal at the water's surface. The animal has the power by some means of rising or sinking at will, probably by means of a modification in the size of the oil globule. Embedded in the jelly outside the capsule are seen conspicuous bright yellow cells, one of which is shown in the act of dividing. These cells contain starch, and are the unicellular algæ, which Brandt has termed Zooxanthellæ. It is obvious that a compound organism such as this is self-supporting, requiring no external source of organic food; and it would be quite possible to conceive the existence of a vast pelagic fauna having Radiolarians combined with their Zooxanthellæ only as a basis. The single organism here represented on the screen is not larger than a pin's head. In the living condition thousands of such are united, clustered together to form little bolsters of jelly about half an inch long, and on calm days on the ocean the whole surface water may be seen full of such masses for miles and miles, as far as the eye can reach, forming a vast supply of self-supporting food for other pelagic organisms. It is probable that the symbiotic condition in Radiolarians is of great importance in the general economy of pelagic life. There are other pelagic animals, for example, Ctenophora, in some of which unicellular algæ are similarly present. Symbiosis may possibly have been more common amongst pelagic faunas of earlier geological epochs, when diatoms apparently were not abundant or non-existent. The Radiolarians are characteristic members of the pelagic fauna. Most of them are provided with most beautiful siliceous skeletons, as, for example, *Rhizospæra leptomita*, now on the screen. It is, as may be seen, provided with a stock of Zooxanthella like Collozoum.

Animals are pelagic in very various degrees, and may be placed under a series of categories accordingly. There are the pelagic animals *par excellence*, those that are found at the greatest distances from shores, and which are capable of passing their whole existence there, and are floated only accidentally to land. Such are the Radiolarians, Siphonophora, very numerous Crustacea, Alciopa, Tomopteris, Heteropods, Ianthina, Pteropods, the Pelagic Cephalopods, Salpæ, and Pyrosoma, and numerous pelagic fish. These might conveniently be termed eupelagic. Then there are others, such as many Scyphomedusæ and most Ctenophora, which, though thoroughly pelagic in habit, are met with in greatest

---

[1] Address at the Southampton meeting of the British Association, August 28, by H. N. Moseley, F.R.S., Professor of Human and Comparative Anatomy, Oxford.

[1] Mr. John Murray has observed that species of pelagic ceratium are to be met with, often forming long chains, composed of individuals united in linear series. I observed an instance of the same fact myself. It seems to give some additional indication of the possibly vegetable nature of certain of the Cilio-flagellata.

numbers near land. There are further numerous animals which are pelagic only in their larval condition, and which, swarming at the surface with the strictly pelagic forms during their early stages, sink to the bottom when mature to lead an entirely different existence. With other pelagic forms, the converse is the case: the pelagic snakes, turtles, and birds come on shore to rear their young, spending most of their adult life on the ocean, and certain whales approach the shore at the breeding season. These two last groups may be termed hemipelagic.

It is impossible to draw a sharp line between any of these groups; they run into one another indefinitely. Thus, unlike the abundant flying-fishes (Exocœtus), the flying gurnets (Dactylopterus), are never found very far from land, but lead a partly pelagic existence, taking frequent flights from the surface, and partly inhabit the bottom in shallow water, being taken sometimes at the bottom with a hook and line. Amongst the Hydromedusæ and Scyphomedusæ, all gradations of pelagic habit occur. Many of both are attached at the sea bottom at certain stages in their life history, or rest on it habitually, some possibly in very deep water; others, closely allied, exhibit no fixed condition, and are entirely pelagic.

The Sargasso Sea has a peculiar fauna of its own, which cannot be considered as strictly pelagic, composed of animals specially adapted to cling to the gulf-weed and inhabit it, and differing in general aspect from other pelagic forms. Very much has been written on this fauna, which is so special that it may well be left out of consideration here.

Most characteristic of pelagic animals is the almost universal crystalline transparency of their bodies. So perfect is this transparency that very many of them are rendered almost entirely invisible when floating in the water, whilst some, even when caught and held up to the light in a glass globe, are scarcely to be seen. The skin, nerves, muscles, and other organs, are absolutely hyaline and transparent in these forms, but natural selection seems to have been unable to render colourless the liver and digestive tract in many instances. So these parts remain opaque, of a yellow or brown colour, and exactly resemble, when seen in the water, small pieces of floating sea-weed. A familiar example is Salpa, Pelagonemertes is another.

Certain few pelagic animals are coloured bright blue for protection, so as exactly to resemble the colours of the waves. Such are Minyas cœruleus, Velella, Porpita, Physalia, Glaucus, Ianthina, all of which are forms which float at the very surface, with part of their bodies more or less out of the water. The blue coloration seems to be connected with this latter circumstance, as protecting the animals probably from predatory pelagic birds, to which they would be invisible at any distance. Velella does not, however, thereby escape its enemies altogether, for a young turtle which we caught at sea during the *Challenger* expedition, had its stomach full of Velellas, and we often found them in the stomachs of albatrosses. Ianthina, the well-known bright blue gastropod, constructs a float built in compartments, which is attached to its foot. If this float be detached, the animal sinks and dies. It is said to be devoid of eyes. Glaucus is a nudibranch mollusc, which has the sides of its body modified into curious fin-like fringed lappets. It floats habitually with its ventral surface upwards, its foot being applied to the surface of the water, just as is that of the common pond snail, Paludina, when the animal is creeping at the surface of the water. In consequence of the position thus assumed by Glaucus, its ventral surface is coloured deep blue, whilst its dorsal or under surface is of a glistening lustrous white. One is so accustomed to animals floating with their back upwards, and being coloured accordingly dark on the back and light underneath, that the appearance of the animal is most deceptive, and, indeed, entirely misled Dr. Bennett, who, in his account of the habits of the animal, speaks of the blue aspect of its body as its back throughout. The curious fish, the Remora,[1] which adheres to sharks and ships, is similarly dark on the exposed ventral surface, and light on the back, and one can hardly persuade oneself of the fact when one looks at one in the fresh condition. The circumstance proves how completely the arrangement of such colouring is protective in object.

Glaucus is most persistent in maintaining its position with its back turned downwards. I turned one over several times. It struggled with its fins somewhat like a turtle on its back, and quickly regained its position. Curiously enough, according to Dr. Bennett, it feeds on Velella, which, like itself, is blue. Similarly the blue Ianthina feeds on the blue Velella.

Some few pelagic animals are most brilliantly coloured, and one small Copepod Sapphirrhina has always excited the admiration of naturalists, being unsurpassed by the brilliant metallic lustre of the humming birds, and displaying all the colours of the spectrum with an intensity like the gleam of the diamond. The figure of this animal now on the screen appears brilliant enough, but it gives but a faint idea of the actual brilliancy of the animal. The colouring in this case is of sexual import, being confined to the males.

A further remarkable fact about pelagic animals is that very many of them have either no eyes or very large eyes, the latter condition being most common. Thus the whole of the Pteropods have either no eyes or mere rudiments of them, and the Siphonophora and Ctenophora have no eyes.

On the other hand, animals with huge eyes in proportion to their size are common in the pelagic fauna. As an example, I shall throw on the screen a representation of the remarkable pelagic Amphipod *Phronima sedentaria*, you observe the enormous size of the compound eyes, which occupy the entire front of the animal's body. The female *Phronima sedentaria* has the curious habit of living in a tub-shaped transparent house, open at both ends, which it forms by gnawing out the inside of a young Pyrosoma colony, and, with its brood of young clustered round it inside, it sculls its tub with great rapidity through the water.

Here you see another crustacean, a Copepod of the genus Corycæus. All the species of Corycæus have a very large pair of eyes; but in the present form the eye apparatus is so extraordinarily enlarged that a large horn-like outgrowth of the body has been formed projecting from under the thorax, in order to accommodate the nervous structures and get a long enough focus for the lenses. This figure is from an unpublished drawing by my lamented colleague on board the *Challenger*, Rudolph von Willemoes Suhm, who specially devoted himself to the investigation of pelagic animals during the *Challenger* voyage. He names in MS. this curious form, which is apparently as yet undescribed Corycæus Megalops. The animal is of a fine blue tint when living. Most remarkable of all for their eyes are, however, perhaps the pelagic annelids, the Alciopidæ. Their eyes are of enormous size and most perfect construction, and far surpass in both respects those of all other annelids.

In thus being blind or provided with extraordinary organs of vision, the members of the pelagic fauna resemble those of the deep-sea fauna, and there are other points of resemblance between the two assemblages of animals, such as that amongst both a large proportion of phosphorescent animals occur. Prof. Fuchs,[1] in lately-published most valuable papers on the Pelagic Flora and Fauna, and on Deep-Sea Life, has dwelt much on these resemblances, and concludes that they are to be explained by the circumstance that, like the deep-sea fauna, the pelagic fauna is to a very great extent a fauna of the darkness, the deep-sea fauna living where darkness, as far as sunlight is concerned, is perpetual, and the pelagic fauna being nocturnal in its habits. By far the greater part of the pelagic fauna is thus nocturnal in its appearance at the surface. In the day-time the animals composing it sink to considerable depths, and they rise only at night. Certain pelagic animals, however, seem not to mind the sunlight. Radiolarians may be seen at the surface when it is calm, in the full glare of the sun, and so may Velellas and Ianthinas; indeed these latter and some others cannot leave the surface. Some Ctenophora, especially Eucharis, according to Chun, seem rather to like the sun. Flying-fish, again, are at the surface day and night, and the beautiful pelagic fish called dolphins (Coryphæna) show their wonderful colours to best advantage in the full sunlight, as they swim lazily round a becalmed vessel. Winds and storms drive all the pelagic animals below which are capable of descending, and one may sail over wide tracts of sea during boisterous weather and imagine that the water is almost barren of life, whereas a calm night would have shown the whole surface teeming with animals.

The important question of the day with regard to pelagic life is, to what depths does it extend? How far do the animals which come up at night descend, and do any which never come to the surface extend their range below the limit of these again; and do any inhabit the region leading down to the very deep sea bottom?

Prof. Weissmann,[2] from his observations on what may be called the pelagic fauna of Lake Constance, has shown that the

---

[1] This fact seems not to be recorded by icthyologists nor figured. When the fish is put in spirits the light tint of the dorsal surface disappears.

[1] Th. Fuchs, "Ueber die Pelagische Flora und Fauna, u.s.w." J. C. Fischer, Wien, 1882.

[2] Das Thierleben in Bodensee. Von Aug. Weissmann. Lindau, 1877.

minute crustacea of which it is composed, slowly rise and sink just like the pelagic inhabitants of the sea. They never sink to a greater depth than twenty-five fathoms, but from this depth they rise gradually to the surface in the evening, following the limit of darkness, as the sun sets, and they descend in the same manner in the morning as the sun rises. Prof. Forel has observed the same facts in the Lake of Geneva. Now a depth of about twenty-five fathoms has been shown by Prof. Forel to be the limit at which sensitised paper ceases to be acted upon by direct sunlight in the waters of the Lake of Geneva. Below this depth no sunlight penetrates. Prof. Weissmann, after trying all other apparent explanations, concludes that the reason why the pelagic crustacea oscillate perpetually in this curious manner in depth is in order to economise the light and be able to feed during the twenty-four hours over their whole possible range of feeding-ground. Were they to remain at the surface during the daylight they could not see at all to feed in the depths in the weak light at night. This most ingenious explanation will no doubt apply equally well to all the marine pelagic animals with well-developed eyes, and which feed on the nearly stationary vegetable matter and *débris* held in suspension by the surface strata of the waters. Whilst the numerous blind forms which execute similar diurnal oscillations, such as the Ctenophora,[1] Echinoderm larvæ,[2] Pteropods, and others, must follow the crustacea and other small fry to feed upon them. Indeed the whole pelagic fauna is so closely inter-dependent, that it must needs move together. It is very probable that some forms come to the surface only at night, because thereby, like so many other nocturnal animals, they escape many possible enemies by always keeping in the dark.

Dr. Chun has observed that the Ctenophora of the Gulf of Naples, after being abundant in spring, become extremely scarce and almost disappear during the three summer months, and re-appear suddenly again in great numbers in the autumn. He believes, from having caught them in the summer at considerable depths, that these Ctenophora descend annually at the end of spring in order to feed on the minute crustacea which then remain in deep water (very possibly because the more powerful light allows them then to feed at the lower level), and that, having become fully fed up, and the young having in the depths passed through their metamorphoses and reached the adult condition, they rise together to the surface, and appear in a swarm as if by magic. One of the Ctenophora with this habit is the beautiful venus girdle (*Cestus veneris*). Scypho Medusæ (*Cassiobeia Borbonica*) and other pelagic animals, appear to perform the same periodical migration in depth. Doubtless similar annual migrations in depth occur amongst pelagic animals in various parts of the world, and this may account for the extraordinary scarcity of some few.

It appears probable, therefore, that pelagic animals perform oscillations in depth from three different causes. They perform, firstly, diurnal oscillations in accordance with the changes in light and darkness; these, secondly, are liable to constant interruptions from the occurrence of boisterous weather; and thirdly, they may alter their depth periodically, according to the season of the year.

The great inland fresh-water lakes have each a regular coast or littoral fauna, a deep-sea fauna, and a pelagic fauna, just like the oceans. The pelagic animals of the lakes resemble those of the sea in many interesting particulars. They are, like them, hyaline and transparent, of most curious forms, modified for a constantly swimming existence, and sometimes possess immensely developed eyes. I shall throw on the screen figures of two crustaceans from the pelagic fauna of the Lake of Geneva, from Prof. Weissmann's figures. Both are Cladocera or water-fleas, of the one-eyed family, Polyphemidæ. The first, Bythotrephes, is of most extraordinary shape, having an enormously long tail spine to balance its top-heavy body; it is transparent like glass, but in late autumn becomes covered with beautiful ultra-marine spots. It has a single enormous compound eye in front, and in the brood pouch, under the rounded carapace on the back is born a single egg. The second, *Leptodora hyalina*, is also of most extraordinary form; it is absolutely transparent, like Bythotrephes, and almost invisible in a glass of water. It has an enormous pair of feathered rowing antennæ to sustain it in the water. This curious animal, as well as a species of Bythotrephes, has lately been discovered by Mr. Conrad Beck in Grasmere Lake, in Westmoreland, together with other Cladocera, so that our own lakes have their pelagic fauna. *Leptodora hyalina* had previously been found by Mr. Bolton in the Olton reservoir near Birmingham.[1]

But the most important question, as I said before, is to what depth do the pelagic animals of the ocean descend? This has remained an unsolved problem ever since it first exercised the mind of the great Johannes Müller, though in his time the question was a different one, being directly connected with that of whether there was any life at the deep-sea bottom or not. An open net sent down to any depth, as it comes up may catch animals at any intermediate depth. Hence it is impossible to assign to any particular depth with any certainty any animals found in a tow-net when raised to the surface. What is required is experiments made with a net so constructed as to be sent down closed to a certain depth, then opened, then towed for some distance, and then raised again to the surface. Such a net has been devised by Capt. Sigsbee, of the U.S. Navy, the inventor of nearly all the best deep-sea apparatus now in vogue, and has been used by Mr. Alexander Agassiz, who found that the pelagic animals on a calm day extended pretty uniformly downwards from the surface to a depth of 50 fathoms, but that at depths of more than 100 fathoms nothing was to be caught at all. Unfortunately very few experiments have as yet been made by Mr. Agassiz with the instrument, and therefore no final conclusions can be drawn from them. We look forward with the greatest interest to further prosecution of similar researches.

On the other hand there is evidence pointing to a further extension in depth of deep-sea forms. On board the *Challenger* my colleague, Mr. John Murray, throughout most of the voyage, made very numerous experiments with the tow-net at great depths, and so constantly obtained very different results by these means to those which were shown by nets simultaneously worked at intermediate depths that he is firmly persuaded that the Pelagic Life extends to very great depths, indeed certain animals which he caught such as the Phœodaria which have been described by Prof. Haeckel, were obtained only from nets which had been down to very great depths. It is indeed possible that there is a direct connection between the deep sea fauna and that of the surface and that the young of certain deep sea fish pass their early existence at the surface amongst the Pelagic throng. It is known with certainty that the young of many fish living in tolerably deep water, such as the cod, inhabit the surface water in their early stages, and it is possible that the eggs of fishes living at great depths may similarly rise to the surface for development. Prof. Lütken[2] has described a small fish which was obtained from the stomach of an albacore which appears without doubt to be the young of a deep sea Lophoid, probably *Himantolophus rheinhardtii*, and the young of other deep sea fish have been found under similar circumstances.

Mr. Agassiz, whose anthority on the matter is of the greatest weight, is nevertheless convinced[3] "that the surface fauna of the sea is really limited to a comparatively narrow belt in depth, and that there is no intermediate belt so to speak of animal life between those animals living on the bottom or close to it and the surface Pelagic fauna." If this be the case then the limit in depth from the surface must be ultimately due to the limit in the penetration of sunlight, and consequent growth of vegetable organisms. Over this belt the ultimate source of food of the Pelagic and deep sea animals is concentrated; below it a constant rain of organic *débris* is always falling slowly,[4] through an immense interval of absolute darkness to the deep sea bottom, but this rain thus spread out is sparse, and being so, it could scarcely be obtained by animals devoid of or unable to employ vision in sufficient quantity to support life.

If the intermediate zone is permanently inhabited at all, such habitation probably depends on the phosphorescence of the animals dwelling in it whereby they are able to use eyes and pick up the scanty food. It is quite possible that some of the fishes endowed with phosphorescent organs such as the Scopeli which, as Dr. Günther reports were brought up in the *Challenger* nets "from any depth to 2,500 fathoms," and some of which occur on the surface, may roam through the intermediate zone finding food by means of their own light, and that may be the

---

[1] Dr. Carl Chun, Fauna and Flora des Golfes von Neapel. Ctenophora, s. 239.

[2] A. Agassiz, North American Star Fishes. Mem. Mus. Comp. Zool. Harvard, 1877, p. 28.

[1] E. Ray Lankester, *Ann. and Mag. Nat Hist.*, January 1882, p. 53.

[2] Vidensk. Selsk. Skr., 5te Række 11te, Bd. v.

[3] Bull. Mus. Comp. Zool. Harvard, Vol. VI., No. 8, p. 153.

[4] By experiment I found that a dead Salpa would take about four days to reach the bottom in a depth of 2,000 fathoms. ("Notes by a Naturalist on the *Challenger*." Macmillan, 1879, p. 582.)

reason why they bear the peculiar organs they do, but the food must be so infinitely more scanty over this intermediate zone than in the upper stratum that life cannot be abundant in it anywhere, and no arrangement such as probably exists at the deep sea bottom whereby unphosphorescent animals profit by the phosphorescence of others can occur. At the ocean bottom the organic *débris* falling from above becomes again concentrated and compressed into infinitely less space than in the surface zone, and life in abundance becomes possible again. The existence of a deep sea fauna at any great distance from coasts depends upon that of a Pelagic fauna overhead.

With a net capable of acting like that of Captain Sigsbee a vast amount of most interesting investigation lies open. We know as yet next to nothing certain as to the curious oscillations in depth and migrations of the Pelagic fauna. The matter would be a very pleasing subject for research for any yachtsman so disposed, who would care to investigate the movements of the surface fauna of our coasts, and I would urge any here present to take it up.

With regard to the connection between Pelagic and Deep-Sea Life, a most important question is the still unsettled one as to the true origin of the Globigerina mud by which so vast an area of the ocean bottom is covered. As is well known, Globigerinæ and other Foraminifera with calcareous shells occur in abundance at the surface of the ocean. They were originally discovered there by Johannes Müller, who was the first to observe in the Mediterranean off the French coast the Pelagic Globigerina and Orbulina which are provided with long fine calcareous spines all over their shells, on which to extend their gelatinous tissue and thus by increasing their volume enable themselves to float. Other surface forms are devoid of spines. The well known Globigerina mud is made up mainly of such shells, and the question is whether the main part of this important deposit is derived from the surface, or whether on the contrary the shells composing it belong to animals living on the deep-sea bottom. Mr. John Murray who spent the whole of the *Challenger* voyage and most of the time which has elapsed since in investigating the surface fauna, and comparing with it the deep-sea deposits writes to me, that he is convinced that in a pure Globigerina mud not 3 per cent. of the carbonate of lime it contains is derived from organisms living on the bottom. On the other hand, Mr. H. B. Brady, the great authority on Foraminifera still seems from the tenour of his short report on the Foraminifera of the *Knight Errant* Expedition, to hold an opposite opinion,[1] although he evidently wavers somewhat.[2] The sarcode contained in the undoubtedly living surface globigerinæ is tough and readily preserved in alcohol. It remains firm after the shell has been removed by acids, and may be readily stained with carmine. There is no reason why the sarcode of deep-sea specimens should not be demonstrated with equal ease, yet it is only very rarely that any is found in them, and even then it appears not to be definite and fresh like that so readily procured from surface specimens, and constantly to be seen in other Foraminifera which certainly live at the bottom. I have never discovered any satisfactory trace of it myself, though I have often sought for it in fresh specimens of globigerina mud. The question whether any form of Globigerina does or does not live on the deep sea bottom is one which still urgently requires a definite answer. The subject of the origin of the Globigerina mud is ably discussed by Butschli,[3] in his account of the Protozoa now in course of issue. One of the principal difficulties in the matter is that much thicker Globigerina shells are found on the bottom, than are met with at the surface. He suggests that the additional thickness may be added to the shell as the animal becoming heavy gradually sinks into deep water out of reach.

An important geological question is connected with the deposition of the Globigerina mud. Prof. Haughton, Dr. Croll, and more lately Mr. Wallace in his "Island Life," have made attempts to arrive at the age of the sedimentary rocks by calculating the time during which a deposit of the mean thickness of the stratified rocks of the globe would be formed on the sea bottom at the present average rate of denudation. In working out this problem Prof. Haughton regarded the materials as spread uniformly over the entire sea bed, whereas Dr. Croll and Mr. Wallace maintain that all the deposit worth consideration may be regarded as taking place within a comparatively short distance of the coast, Mr. Croll believing that the deposit taking place beyond a distance of 100 miles on an average is not very great, and Mr. Wallace reducing the area of hypothetical deposition to a very much less breadth. Now both of the latter observers seem to have forgotten that the whole of the organic deep-sea deposits, all over the ocean beds must be taken into consideration in any such calculations, quite as much as any deposits of insoluble silts which may be formed near shore. The vast deposits of calcareous globigerina mud, the siliceous Radiolarian and Diatomaceous deposits and the abundant red clays of the still deeper areas are as much the products of the present denudation of the earth's surface, as the banks formed near the river mouths. There is no other source from which they can be derived. A considerable amount of the results of denudation is carried by the rivers into the ocean in solution, and a further quantity doubtless becomes dissolved by the sea water when the river water is mixed with it, and the Pelagic Foraminifera and other animals assimilating it carry it far from the coasts all over the oceans and deposit it in the deep sea, spreading it evenly over the bottom.

A large quantity of the sedimentary rocks taken into consideration in one side of the calculations referred to, resemble the deep-sea deposits in being mainly ultimately or directly deposited through organic agents.

I cannot but think that some modification of the results attained in the calculations referred to may be required on this consideration, and life allowed to add a few more tens of thousands of years to her age.

The whole existence of the Pelagic fauna depends on the denudation of the land, were it not for this the supply of mineral matter in the sea water would have become exhausted long ago.

The Pelagic animals prey upon one another largely. The voracity of some of the most harmless looking jelly-like forms is extraordinary, Dr. Chun describes the Ctenophor Beroe as swallowing another Ctenophor much larger than itself with the greatest rapidity distending its body enormously in the act. Many of the larger pelagic animals, like the whalebone-whale, feed on large quantities of minute animals, Prof. Steenstrupp has found that certain Pelagic Cephalopods feed on minute crustacea and the use of the wide conical membrane surrounding the arms in the Cirrhoteuthidæ is apparently to catch shoals of Entomostraca. Similarly the Penguins of the southern sea seem to feed largely on minute crustacea. Their stomachs are to be found crammed with them. In catching them they move through the water with immense rapidity, and all such feeders are endowed with immense muscular power. Other pelagic Cephalopods may be seen at the surface in droves pursuing shoals of fish and squirting the water from their funnels into the air in small jets in all directions.

A most remarkable fact is that certain larval forms of shore animals undergo extraordinary modifications under the influence of Pelagic existence. The best known instance in point is that of the Leptocephali, which are small ribbon-shaped fishes absolutely transparent, and in many cases devoid of any hæmoglobin in their blood, whilst the slight skeleton they possess is cartilaginous only, and the whole tissues are soft and pulpy. They are often abundant at the sea surface far from land, but are never found sexually mature. There seems to be no doubt that the most abundant of these forms are the young of conger eels, but off many coasts, as for example, that of Norway, where congers are abundant, no Leptocephali are ever found. Dr. Günther's conclusion is that all these curious fish are the results of the abnormal development of the larva of various fishes (possibly sprung from eggs accidentally shed at the surface instead of the bottom), which continue to grow to a certain size without corresponding development of their organs, and perish without ever becoming mature.

Another instance of similar modification is that of the young flat fish termed Platessæ, which are like the Leptocephali perfectly transparent. These are also often taken in the open ocean and it appears probable that when thus placed under unnatural circumstances their development becomes arrested, and many probably perish eventually, like the Leptocephali, without the arrangement of their eyes ever becoming unsymmetrical. The deep sea is devoid of flat fish and it seems impossible that the larvæ should ever find their way back to shore.

In the case of the young of the Flying Gurnet something analogous occurs. In the minute young a reversion to the ancestral condition is exhibited, the pectoral fins are not longer in proportion to the fishes' body than those of other fish, they only begin to develope into wings when growth has proceeded

---

[1] Exploration of the Faroe Channel during the summer of 1880, by Staff Commander Tizard, R.N., and John Murray. *Proc. R. S. Edin.*, 1881-82, p. 80.

[2] Notes on Reticularian Rhizopoda (*Quart. Journ Micros. Sci.*, 1881, p. 67.

[3] Bronn Klassen u. Ordnungen des Thierreichs, Protozoa, 1880, p. 166.

very far, but as Prof. Lütken[1] has shown the degree of development of the pectoral fins bears no constant relation to the size attained by the young fish, a great increase in size may occur without a corresponding progress in metamorphosis. In consequence of this the young of the common flying Gurnet *Dactylopterus volitans*, were not for long recognised as such but were considered distinct and named Cephalacanthus. A parallel instance to that of Leptocephalus is possibly that of the curious flattened larva of the Rock Lobster (Palinurus) Phyllosoma, which is also found in the open ocean attaining sometimes gigantic proportions. Possibly also other pelagic larvæ become thus hypertrophied in the larval condition. We may compare with these phenomena the somewhat parallel modifications which occur naturally or may be produced artifically amongst larval Amphibians.

Many of the Pelagic animals carry with them parasites similar to those affecting their littoral allies and which thus are, as it were, imported into the Pelagic fauna, but there are a few definitely pelagic parasites parasitic upon pelagic hosts. The young of the Pelagic annelid Alciopa are parasitic within the bodies of Ctenophora, there is the small parasitic Hydromedusa Mnestra, which adheres to Phyllirhoe, and lastly there are the young Cunina medusæ which cling in dense clusters within the stomach of the Geryonid Medusa Carmarina, and were at first imagined to be the young of the Carmarina itself.

A remarkable feature about Pelagic animals is that very many of them occur in large swarms, some in immense hosts. Further Velellas, Porpites, and Ianthines are always met with in schools, and even Leptocephali, and very many other forms are usually caught in the tow-net, several at a time.

In their almost universal geographical distribution except as regards the colder seas, Pelagic animals resemble the deep-sea fauna ; as examples it may be mentioned that according to Prof Lutken, the tunny of the Mediterranean is identical with that of Japan, and the albacore of the Atlantic with that of the Pacific. Pelagic genera seem to be of almost ubiquitous distribution, though the Atlantic and Pacific species frequently differ.

Some few Pelagic forms seem to be remarkably scarce. As an instance may be cited Pelagonemertes, the curious Pelagic Nemertine with a ramified intestine. This form was obtained in great abundance by Lesson at the surface in 1830, between the Moluccas and New Guinea. By the *Challenger* it was found twice, only a single specimen being got on each occasion. The first was caught to the south of Australia, and the second on the coast of Japan. The animal seems never to have been met with by any one excepting on these three occasions. On each occasion when caught by the *Challenger* it was found in a trawl which had been down to a great depth. It is therefore very possible that it very rarely rises to the surface.

Similarly many Pelagic Cephalopods though known to exist in multitudes are of the greatest rarity, being only known from fragments. Bushels of their horny beaks are found in the stomachs of whales, which subsist on them, and several genera are known to Prof. Steenstrupp only from these quantities of beaks. He has never seen a trace of any other part of them.

Notwithstanding the wide distribution of Pelagic forms, Mr. Murray finds that he is able to form tolerably correct conclusions as to the latitude of any sample of deep-sea bottom which contains organic remains submitted to him, from the nature of the Pelagic debris of which it is composed. He can also form some idea of the depth from which a deposit has been brought up by observing the extent to which the substance of the calcareous shells has undergone solution. Pteropod shells owing to their extreme thinness appear to be dissolved first, and disappear say at 1200 fathoms, then the finest globigerina shells at 2200, then the larger globigerina shells and so on.

Pelagic animals as a rule appear to be extremely sensitive to any lack of saltness in the water. The surface fauna of the Baltic is thus very poor, and in the upper part consists of little else than a few small crustacea, but curiously enough the large Scyphomedusæ, such as Aurelia and Cyanea appear to be unaffected injuriously by a brackishness of the water but rather to prefer it. They extend in the Baltic into places where the water is very little salt and I have seen similar large Scyphomedusæ swimming in shoals at the head of one of the large creeks of the Hawkesbury inlet in New South Wales, in the actual current of a small fresh-water stream which ran in and where the water was quite drinkable. This is all the more remarkable because as Mr. Romanes has shown the one Hydromedusa which we know of as confined to fresh water, the well known Lymnocodium of the Victoria lily tank in the Regent's Park Botanical Gardens, is excessively sensitive to any addition of salt to the water in which it is.

I am informed by Mr. George Baden Powell that the large Medusæ so abundant here at Southampton, shows a curious tendency to crowd up towards the higher part of Southampton water. There are hardly any to be found as a rule in the Solent but they appear always to tend to crowd up at the heads of estuaries. I have noticed in Norway also that they appear to crowd at the heads of the Fjords.

I shall now proceed to some remarks on the zoological composition of the Pelagic fauna and its probable history in the past. The present Pelagic fauna may be regarded as consisting of two constitutents, firstly, a number of species belonging to a series of orders and subclasses which are absolutely peculiar to it, that is to say, which have no representatives which are littoral or terrestrial, and are not at any period of their existence other than Pelagic. We may reckon about nine such groups. There is no group which rises undoubtedly to the rank of a class which is thus Pelagic only. The groups are as follows, the Siphonophora, Ctenophora,[1] Chætognatha, Heteropoda, Pteropoda, Larvalia, Salpæ, Pyrosomidæ, Cetacea.

Of the antiquity of the Siphonophora we know nothing directly, for they do not occur at all as fossils, and as they are like most pelagic forms ill adapted for preservation as fossils, it is impossible to conjecture whether they are of quite modern or of ancient origin. They are complex colonies of animals of various forms united together and performing separate functions for the common good of the colony. They are offsets of the Hydromedusæ, and thus derived originally from a pelagic planula ancestor, but it seems uncertain whether they have subsequently sprung from a once fixed hydromedusa stock set free, or have been free and pelagic throughout their history. The Ctenophora are also an offset from the Hydromedusæ; they also have as yet no geological history. Their ancestors have probably always from the planula upwards led a free pelagic life. The history of the Chætognatha (Sagitta) is obscure. The Heteropods and Pteropods are derived from a common pelagic veliger ancestor which existed as early at least as Silurian times, and this ancestor probably descended from a trochosphere also pelagic.

The Larvalia, the Ascidian Appendicularia and its allies, near relatives of the ancestral vertebrata, probably have always been Pelagic and have existed in something like their present form from a very early period, whilst the Pyrosomidæ after branching off from the same stock as simple animals have possibly undergone a fixed sessile condition as compounds before becoming again Pelagic.

If Prof. Ray Lankester is correct in his suggestion (in his British Association lecture on "Degeneration") that very possibly an ancestor of all the vertebrata, including man himself was once pelagic, because the peculiar mode of the development of the eye of vertebrates can only be accounted for by the supposition that the tissues of the head were completely transparent and from other considerations ; then the whales are now so to speak for the second time pelagic in the history of life. Their more immediate ancestors, allies of the seals, and sprung from the common progenitor of the stock of placental mammals, took afresh to the sea and gradually relinquished the shore altogether.

The second division of the Pelagic fauna is composed of numerous representatives of various classes and orders of animals, the majority of members of which are inhabitants of the sea bottoms, shores or land surfaces, but which representatives are mostly specially modified in remarkable ways to fit them for pelagic existence. Only a few of these can now be touched on. Although there are abundance of Cilioflagellata which are pelagic, there seem to be very few true Infusoria (or Ciliata) which are so, at least very few have as yet been recorded as such, and none at all known from any great distances from land. The few as yet known all belong to one family of the Peritricha, the Tintinnidæ. Codonella, one of them, of which a representation is now on the screen, is bell-shaped and remarkable for being provided with a siliceous protecting shell.

There are even sea anemonies which have taken to Pelagic existence, and are to be found in great quantities on the ocean surface at times. They are exactly like the ordinary sea anemonies of our shores, excepting that their base instead of

---

[1] Ch. Lutken, Spolia Atlantica. Copenhagen, 1880, p, 426.

[1] It is possible as suggested by the late Prof. Balfour, that Kowalensky's Cœloplana may prove to be a creeping Ctenophor.

being flat for adherence to rocks is closed in so as to hold a small mass of air. Suspended by the buoy so formed, they float at the surface mouth downwards. The one of which a figure is now on the screen *Minyas cærulea*, is remarkable as being one of the small band of Pelagic animals which is coloured deep blue. There are also Pelagic insects of the genus Halobates of the Bug family, and closely allied to the common water bugs which skip on the surfaces of our ponds. Halobates is found clinging to the surface of the waves at all distances from land in the open oceans, and outrides the heaviest storms.

There are many Pelagic fishes; I have already shown you the dolphin (Coryphæna). Here is a figure of one of the Ribbon Fishes, the scarce Regalecus. This fish has usually been supposed to be a pelagic fish, but Dr. Gunther is persuaded that it is a true deep-sea fish, though it has not yet been caught in any deep-sea net, only picked up dead on the surface. There are many similar fishes about which some difference of opinion as yet exists as to their habits. The young of the Ribbon Fishes are found alive at the sea surface, and the group may therefore perhaps yield another instance of the connection of Pelagic with deep-sea forms. The Pelagic snakes are interesting as, to some extent, modern representatives of the Eocene sea serpents (Titanophis), for though they come on shore to produce their young, their existence is mostly spent at the sea surface often far from land, and they are specially modified both in the structure of their lungs, and the ribbon-like flattening of their tails for pelagic existence.

There is one lizard, the well known Amblyrhynchus of the Galapagos Islands, described by Mr. Darwin in his Journal, which though it cannot in any way be termed pelagic swims out to sea, and as the only recent one which does so is worth mention as a sort of representative of the gigantic pelagic lizards of Mesozoic periods such as Mososaurus.

With so many groups of the animal kingdom contributing to the Pelagic fauna, it is remarkable that some large groups should be entirely unrepresented within it. There are no adult Pelagic sponges, no Alcyonarians, no Sipunculids, no Brachiopods, no Lamellibranchs, and lastly no Echinoderms. Considering the curious adaptations to Pelagic life which have been undergone by such forms as sea anemonies, nemertines, compound ascidians and gasteropods, it is most easy to conceive how Lamellibranchs for example taking after the habit of flying as it were butterfly fashion through the water like *Lima hyans*, might have become Pelagic, and how Echini taking after Minyas, or Comatulæ swimming with their arms or Holothurians in various ways might have assumed a Pelagic dress, but no Lamellibranch, and no Echinoderm seems ever in the long record of the past to have been Pelagic since the time of their earliest Pelagic ancestors, unless possibly Saccoma of the lithographic state was Pelagic.

With regard to the history of the Pelagic fauna in the past. There can be no doubt, as Prof. Weissmann so well puts it, that "the birth place of all animal and plant life lay in the sea." It is probable that a considerable part of earliest life which existed must have been Pelagic, and that the ancient Pelagic fauna was to a large extent the parent of all other life. The developmental history of all marine animals points clearly in this direction, closely similar transparent Pelagic larval forms being common to groups of widely different adult littoral forms. The resemblance between the larvæ of these adult forms can hardly be conceived to have been arrived at by natural selection after the adult forms had already diverged from one another. It is only to be explained on the hypothesis of an original Pelagic ancestral condition. One of the Monera, Protomyxa aurantiaca, is even now a Pelagic form, having been found by Prof. Haeckel adhering to a floating spirula shell.

From the recent interesting researches of Dr. Nathorst,[1] we know that Scyphomedusæ closely like those now swimming in Southampton Water, were already amongst the Pelagic fauna of the Cambrian Sea, whilst the mud at the same time swarmed with annelids very similar to those now existing. At the same remote epoch Brachiopods, Corals, Echinoderms, Crustacea, and other forms were already present on the coasts.

The Precambrian Pelagic fauna must therefore probably have contained sexually mature representatives of the Planula, the Bilateral Echinoderm larva, the Ephyra (which survives as such to the present day), the Trochosphere and the Nauplius. During the Cambrian period or earlier, was added the Cypris ancestor of Cirripeds, and the vertebrate ancestor, and the Trilobite Æglina with gigantic eyes found its place in the dim light somewhere, possibly amongst the Pelagic fauna. In Silurian times Pteropods were added to the Pelagic throng, some gigantic forms of which nearly a foot in length are now extinct, whilst one genus then present still flourishes in modern seas, the Heteropods also appeared (Bellerophon) and Cirriped larvæ, and the Graptoliths, possibly Pelagic, appeared and became extinct. In the Devonian period certain sharks and rays and ganoid fishes probably took to Pelagic life. Pelagic representatives of the sharks and rays still flourish, but the ganoids have retreated to the fresh waters. In the early Secondary period Globigerina appeared and a few Radiolarians, and the dibranchiate cephalopods came into being and soon the sea swarmed with the Pelagic Belemnites. The air-breathing reptiles whose ancestors had quitted sea life and gone on shore came back to Pelagic life and the Ichthyosaurus with enormous eyes chased the Pelagic prey in the depths, or hunted at night. Somewhat later the ancestors of the Mososaurids took to the sea; and their progeny became entirely Pelagic and as huge as whales.

In early tertiary times, or shortly before that, various mammalia took to the sea, and amongst them the whales became entirely pelagic and relinquished the shore altogether. Some animals have apparently taken to oceanic life, in very recent times indeed. Ianthina is an instance in point, it has not as yet been discovered in the fossil condition at all, nor any close allies of it.

Somewhat thus has the Pelagic fauna grown up, having been partly composed of animals: the ancestry of which has probably led a Pelagic life from the earliest times, and partly added to, at all ages by inhabitants of the coast, and the dry land which have as it were from time to time run away to sea.

In conclusion, I can only say that it has given me the greatest pleasure to address a lecture to you on the present subject in a city, the population of which is itself so largely Pelagic. It is to a considerable extent through the careful collecting of the Captains of merchant vessels interested in zoology on the high seas, who have gathered specimens for the Museums of their home ports, that many of the facts I have laid before you to-night have been brought to light, and all praise is due to them for the fact.

UNDERGROUND TEMPERATURE

THE Underground Temperature Committee of the British Association have presented a summary (drawn up by Prof. Everett) of the results contained in all their reports (fifteen in number) up to the present date, of which the following is an abridgment:—

The results are classified under the heads: A. Instruments. B. Methods of observation. C. Questions affecting correctness of observations. D. Questions affecting deductions from observations. E. Comparison of results. F. Mean rate of increase of temperature with depth, and mean upward flow of heat.

A. INSTRUMENTS.—Under this head we have: 1. Instruments for observing temperature. 2. Subsidiary apparatus.

1. The thermometers which the Committee have employed have been of two kinds—slow-action thermometers and maximum thermometers. The present pattern of slow-action thermometer consists of a thermometer having its bulb surrounded by stearine or tallow, the whole instrument being hermetically sealed within a glass jacket, and had its origin in a conference between the secretary and Dr. Stapff in the St. Gothard Tunnel.

Our present patterns of maximum thermometer are two—the Phillips, and the Inverted Negretti—both being hermetically sealed in strong glass jackets to prevent the bulbs from receiving pressure when lowered to a great depth in water.

Both instruments are used in a vertical position, and they register truly in spite of jolts in hauling up.

References to Becquerel's thermo-electric method of observing underground temperature were made in three of the reports, and some laboratory experiments were subsequently carried out by the secretary, which led to the conclusion that the method could not be relied on to yield sufficiently accurate results. It may be mentioned that Becquerel's observations are only carried to the depth of 100 feet, whereas we require observations at the depth of 1000 or 2000 feet.

2. Under the head of subsidiary (that is non-thermometric)

---

[1] Svenska Vetensk. Akad. Hand., No. 7, Bd. xviii.

apparatus, plugs for preventing convection-current in a bore or well are referred to. Prof. Lebour's umbrella-like plug, in its final form, appears to be very convenient, as it requires only one wire. It remains collapsed so long as the wire is taut, but opens out and plugs the hole when it becomes slack.

B. METHODS OF OBSERVATION.—These have chiefly been of two kinds: 1. Observations in holes bored to the depth of a few feet in newly-opened rock, either in the workings of a mine or a tunnel, or in a shaft during the sinking. The rock should not have been exposed for more than a week when the hole is bored, and a day may be allowed to elapse for the heat generated by boring to escape before the thermometer is inserted. Very complete plugging is necessary to exclude the influence of the external air. It is desirable to use about two feet of plugging, of which the outer part should be made air-tight with plastic clay or greased rag. After the lapse of a few days, the thermometer is to be drawn out by means of a string attached to the handle of its copper case, and the reading taken. The slow-action thermometer above described is employed for this purpose, and there is time to read it with sufficient deliberation before any appreciable change occurs in its indication. It is recommended that the thermometer be then reinserted and plugged as before, and a second reading taken after the lapse of a week. The majority of our successful observations have been made by this method.

2. Observations in deep bores of small diameter. The first report contained a successful application of this method to a bore about 350 feet deep, near Glasgow, which gave very regular results in a series of observations at every sixtieth foot of depth; but in the majority of instances in which it has since been applied, there have been marked irregularities, due apparently to the influx of water from springs at particular points. One of the most valuable of our results was obtained by the application of the method to a bore 863 feet deep, executed at the bottom of a coal mine 1066 feet deep, giving a total depth of 1929 feet. The bore in this case was dry at the time of its execution, though full of water at the time of the observation. It was in South Hetton Colliery, Durham. The instrument generally employed in the observations of this class was a maximum thermometer of either the Phillips or the Inverted Negretti construction.

The larger the diameter of the bore, the more uncertain does this mode of observation become. The South Hetton bore had a diameter of 2½ inches. The Kentish Town well, 1000 feet deep, in which Mr. Symons' observations were made, had a diameter of 8 inches, and the well 660 metres deep at La Chapelle, in the north of Paris, had a diameter of 4½ feet (V., VI., VII.). The temperatures in this last were proved to be largely affected by convection, the water at the top being too warm, and that at the bottom not warm enough. The observations of Herr Dunker, in the bore at Sperenberg, near Berlin, with a depth of 3390 feet and a diameter of 12 inches, proved a similar disturbance, amounting at the top and bottom, to several degrees. As regards the bottom, the proof consisted in showing that when a thermometer at the bottom was protected by a tight plug from the influence of the water above, its indications were higher by 3° R. (= 6¾° F.) than when this precaution was not employed.

C. QUESTIONS AFFECTING THE CORRECTNESS OF THE OBSERVATIONS MADE might theoretically include questions as to the correct working of the instruments employed, and as to the personal reliability of observers; but the latter topic has not come into discussion, and the former has not arisen since our present patterns of instrument came into use. The questions for discussion are thus confined to those which relate to possible differences between the temperature of the point at which the thermometer was placed and the normal temperature at the same depth in its vicinity.

1. The heat generated by the action of the boring tool will vitiate the observation if sufficient time is not allowed for its escape.

A very full discussion of this subject in connection with the great artesian well at La Chapelle will be found in reports V., VI., and VII., clearly establishing the fact that the temperature at the bottom both on the third and the sixth day after the cessation of boring operations, was 7¼° F. higher than after the lapse of four months, though the water had been left to itself during this interval. Further evidence showing that the temperature in the lower part of a bore full of water may thus be raised several degrees, is furnished by the Sub-Wealden bore.

2. The generation of heat by local chemical action is well known to be a powerful disturbing cause when pyrites is present. The observers in the mines of Schemnitz say, "Pyrites and also decaying timber were avoided, as being known to generate heat." The observations in the coal mines of Anzin show a temperature of 70¾° F. in shaft IV. (a very dry one) at the depth of 21·2 metres, or less than 70 feet. This must be about 15° F. above the normal temperature. In shaft II. the observer mentions that there was, at a depth of 90m., a seam of coal in which heat was generated by oxidation.

At Talargoch lead mine, in Flintshire, the discrepancies between the temperatures at the six observing stations are suggestive of local chemical action.

3. Convection of heat has proved a very troublesome disturbing cause.

As to convection of heat by air in a shaft or well not filled with water, evidence will be found in the second report, both in the case of Mr. Hunter's observations in the shafts of two salt mines at Carrickfergus, having the depths of 570 and 770 feet respectively, and in the case of Mr. Symons' observations at Kentish Town, where the first 210 feet of the well are occupied with air. At the depth of 150 feet the temperature was 52·1 in January, and 54·7 in July.

Convection of heat by water in old shafts which have been allowed to become flooded, is very manifest in some of the observations communicated by Mr. Burns in the second and fourth reports. In Allendale shaft (Northumberland), 300 feet deep, with about 150 feet of water, the temperature was practically the same at all depths in the water, and this was also the case in Breckon Hill Shaft, where the observations extended from the depth of 42 feet to that of 350 feet. A similar state of things was found in a shaft at Ashburton (Devon) by Mr. Amery, who observed at every fiftieth foot of depth down to 350 feet.

Convection by water in the great well at La Chapelle, 660 m. (2165 feet) deep, and 1·35 m. (4 feet 5 inches) in diameter at the bottom, appears probable from the following comparisons:—

Very concordant observations (communicated by M. Walferdin to *Comptes rendus* for 1838) at three different wells in the Paris basin of the respective depths of 263 m., 400 m., and 600 m., show by comparison with one another and with the constant temperature in the artificial caves under the Paris Observatory a rate of increase of 1° F. in 56 or 57 feet. These data would give, at the depth of 100 m., or 328 feet, a temperature of 57°, and at the depth of 660 m., or 2165 feet, a temperature of 90°; whereas the temperatures actually observed at those depths in the well at La Chapelle in October, 1873, when the water had been undisturbed for a year and four months, were 59°·5 and 76°. It thus appears probable that the upper part of the well is warmed, and the lower part cooled, by convection. Further light may be expected to be thrown on this point when the well reaches the springs, and the water spouts above the surface, as it does at the Puits de Grenelle. A letter received by the secretary in July, 1882, states that engineering difficulties have prevented any deepening of the well since the above observations, but that arrangements for this purpose have now been made.

More certain and precise information as to the effect of convection in deep bores is furnished by the experiments of Herr Dunker at Sperenberg. The principal bore at Sperenberg has a depth of 4052 Rhenish, or 4172 English feet, and is entirely in rock salt, with the exception of the first 283 feet. Observations were first taken (with a maximum thermometer on the overflow principle) at numerous depths, from 100 feet to the bottom, and showed a fairly regular increase of temperature downwards. The temperature at 700 feet was 16°·08 R., and at 3390 feet 34°·1 R. Plugs were then contrived which could be fixed tight in the bore at any depth with the thermometer between them, or could be fixed above the thermometer for observing at the bottom. Convection was thus prevented, and a difference of one or two degrees Réaumur was found in the temperatures at most of the depths; at 700 feet the temperature was now 17°·06 R., and at 3390 feet 36°·15. We have thus direct evidence that convection had made the temperature at 3390 feet 2°·05 R., or 4°·6 F. too low; and this, as Herr Dunker remarks, is an under-estimate of the error, inasmuch as convection had been exerting its equalising action for a long time, and its effect could not be completely destroyed in the comparatively short time that the plugs were in position. Again, as regards the effect of convection on the upper part of the bore, the temperature 11°·0 R was observed at the depth of 100 feet in the principal bore when no plugs were employed, while a second bore only 100 feet deep in its immediate vicinity showed a temperature 9°·0 R. at the bottom. This is direct evidence that the water near the top of the great bore had been warmed 2° R., or 4½° F. by convection.

Suggestions for observations in filled-up bores will be found in the eleventh report, but they have not yet taken a practical shape.

D. QUESTIONS AFFECTING DEDUCTIONS FROM OBSERVATIONS.—1. In many instances the observations of temperature have been confined to considerable depths, and in order to deduce the mean rate of increase from the surface downwards it has been necessary to assume the mean temperature of the surface. To do this correctly is all the more difficult, because there seems to be a sensible difference between the mean temperature of the surface and that of the air a few feet above it.

In the third report some information on this point is given, based on observations of thermometers 22 inches deep at some of the stations of the Scottish Meteorological Society, and of thermometers 3 (French) feet deep at Greenwich and at Edinburgh. These observations point to an excess of surface-temperature above air-temperature, ranging from half a degree to nearly two degrees, and having an average value of about one degree.

Dr. Schwartz, Professor of Physics in the Imperial School of Mines at Schemnitz, in sending his observations made in the mines at that place, remarks on this point:—

"Observations in various localities show that in sandy soils the excess in question amounts, on the average, to about half a degree Centigrade. In this locality the surface is a compact rock, which is highly heated by the sun in summer, and is protected from radiation by a covering of snow in winter; and the conformation of the hills in the neighbourhood is such as to give protection against the prevailing winds. Hence the excess is probably greater here than in most places, and may fairly be assumed to be double the above average."

Some excellent observations of underground temperature at small depths were made at the Botanic Gardens, Regent's Park, London, for the six years 1871-76, along with observations of air-temperature, and have been reduced by Mr. Symons. They are at depths of 3, 6, 12, 24, and 48 inches beneath a surface of grass, and their joint mean derived from readings at 9 a.m. and 9 p.m. for the six years is 49·9, the mean for the 48-inch thermometer being 50·05. The mean air-temperature derived in the same way from the readings of the dry-bulb thermometer is 49·6. Hence it appears that the excess of soil above air is in this case about 0°·4.

Quetelet's observations for three years at Brussels (p. 48 of his "Mémoire") make the earth, at depths less than 1¼ foot, colder than the air, and at greater depths warmer than the air.

Caldecott's observations for three years at Trevandrum, in India, make the ground at the depth of 3 feet warmer than the air by 5°·7 F.

Dr. Stapff, in his elaborate publications on the temperature of the St. Gotbard Tunnel, arrives at the conclusion that the mean temperature of the soil on the surface of the mountain above the tunnel is some degrees higher than that of the air, the excess increasing with the height of the surface and ranging from 2° or 3° C. near the ends of the tunnel, to 5° or 6° in the neighbourhood of the central ridge.

2. Connected with this is the question—Whether the mean annual temperature of the soil increases downwards from the surface itself, or whether, as is sometimes asserted, the increase only begins where annual range ceases to be sensible—say at a depth of 50 or 60 feet.

The general answer is obvious from the nature of conduction. Starting with the fact that temperature increases downwards at depths where the annual range is insensible, it follows that heat is travelling upwards, because heat will always pass from a hotter to a colder stratum. This heat must make its way to the surface and escape there. But it could not make its way to the surface unless the mean temperature diminished in approaching the surface; for if two superposed layers had the same mean temperature, just as much heat would pass from the upper to the lower as from the lower to the upper, and there would not be that excess of upward flow which is necessary to carry off the perennial supply from below.

This reasoning is rigorously true if the conductivity at a given depth be independent of the temperature, and be the same all the year round. By "conductivity" we are to understand the "flux of heat" divided by the "temperature-gradient"; where by the "flux of heat" is meant the quantity of heat which flows in one second across unit-area at the depth considered, and by the "temperature-gradient" is meant the difference of temperature per foot of descent at the depth and time considered.

Convection of heat by the percolation of water is here to be regarded as included in conduction. If the conductivity as thus defined were the same all the year round, the increase of mean temperature per foot of depth would be independent of the annual range, and would be the same as if this range did not exist.

As a matter of fact, out of six stations at which first-class underground thermometers have been observed, five show an increase downwards, and one a decrease. The following are the results obtained for the depths of 3, 12, and 24 French feet:—

	3 feet.	12 feet.	24 feet.
Brussels, three years	51·85	53·69	53·71
Edinburgh (Craigleith) five years ...	45·88	45·92	46·07
,, (Gardens) five years ...	46·13	46·76	47·09
,, (Observatory), seventeen years	46·27	46·92	47·18
Trevandrum (India), three years ...	85·71	86·12	—
Greenwich, fourteen years	50·92	50·61	50·28

In calculating the mean temperature at 12 feet for Trevandrum, we have assumed the temperature of May, which is wanting, to be the same as that of April.

Omitting Trevandrum, and taking the mean values at 3 and 24 French feet, we find an increase of ·656 of a degree in 21 French feet, which is at the rate of 1° for 32 French, or about 34 English feet.

3. Another question which it has sometimes been necessary to discuss is the influence which the form of the surface exerts on the rate of increase of temperature with depth.

The surface itself is not in general isothermal, but its temperature is least where its elevation is greatest; the rate of decrease upwards or increase downwards being generally estimated at 1° F. for 300 feet. This is only about one-fifth of the average rate of increase downwards in the substance of the earth itself beneath a level surface. If the two rates were the same, the isotherms in the interior of a mountain would be horizontal, and the form of the surface would have no influence on the rate of increase of temperature with depth. The two extreme assumptions that the surface is an isotherm, and that the isotherms are horizontal, lie on opposite sides of the truth. The isotherms, where they meet the sides of the mountain, slope in the same direction as the sides of the mountain, but to a less degree. Probably the tangents of the two slopes are generally about as 3 to 4.

Further, if we draw a vertical line cutting two isotherms, the lower one must have less slope than the upper, because the elevations and depressions are smoothed off as the depth increases.

The practical inference is that the distance between the isotherms (in other words, the number of feet for 1° of increase), is greatest under mountain crests and ridges, and is least under bowl-shaped or trough-shaped hollows.

The observations in the Mont Cenis tunnel, and the much more complete observations made by Dr. Stapff in the St. Gothard tunnel, fully bear out these predictions from theory. The discussion of the former occurs in the fourth report, p. 15.

As regards the St. Gothard tunnel, Dr. Stapff reports:—"The mean rate of increase downwards in the whole length of the tunnel is ·02068 of a degree Centigrade per metre of depth, measured from the surface directly over. This is 1° F. for 88 feet. Where the surface is a steep ridge the increase is less rapid than this average; where the surface is a valley or plain the increase is more rapid."

4. The question whether the rate of increase downwards is upon the whole the same at all depths, was raised by Prof. Mohr in his comments upon the Sperenberg observations, and is discussed, so far as these observations bear upon it, in the 9th and 11th reports.

Against the Sperenberg observations, which upon the whole show a retardation of the rate of increase as we go deeper, may now be set the Dukinfield observations begun by Sir William Fairbairn, and continued by Mr. Garside. Taking Mr. Garside's observations, and assuming a surface-temperature of 49°, the increase in the first 1987½ feet is at the rate of 1° in 79·5 feet; in the next 420 feet it is at the rate of 1° in 70 feet, and in the last 283½ feet it is at the rate of 1° in 51½ feet.

From a theoretical point of view, in places where there is no local generation of heat by chemical action, the case stands thus:—

The flow of heat upwards must be the same at all depths, and this flow is equal to the rate of increase downwards, multiplied by the conductivity, using the word "conductivity" (as above explained) in such a sense as to include convection. The rate of increase downwards must, therefore, be the same at all depths at which this conductivity is the same.

This reasoning applies to superposed strata at the same place, and assumes them to be sufficiently regular in their arrangement to ensure that the flow of heat shall be in parallel lines, not in converging or diverging lines.

5. If we have reason to believe that the flow of heat upwards is nearly the same at all places, then the above reasoning can also be applied approximately to the comparison of one place with another—that is to say, the rates of increase downwards, in two masses of rock at two different places, must be approximately in the inverse ratio of their conductivities. In the cooling of a heated sphere of heterogeneous composition, the rates of flow would at first be very unequal through different parts of the surface, being most rapid through those portions of the substance which conducted best; but these portions would thus be more rapidly drained of their heat than the other portions, and thus their rates of flow would fall off more rapidly than the rates of flow in the other portions. If the only differences in the material were differences of conductivity, we might on this account expect the outflow to be after a long time nearly the same at all parts of the surface. But when we come to consider differences of "thermal capacity per unit volume," it is clear that with equal values of "diffusivity," that is of "conductivity divided by thermal capacity of unit volume" in two places, say in two adjacent sectors of the globe, there would be the same distribution of temperatures in both, but not the same flow of heat, this latter being greatest in the sector in which the capacity and conductivity were greatest.

Where we find, as in Mr. Deacon's observations at Bootle, near Liverpool, and to a less marked degree in the observations of Sir William Fairbairn and Mr. Garside, near Manchester, an exceptionally slow rate of increase, without exceptionally good conductivity, it is open to us to fall back on the explanation of exceptionally small thermal capacity per unit volume in the underlying region of the earth, perhaps at depths of from a few miles to a few hundred miles.

6. A question which was brought into consideration by Prof. Hull, in connection with the great difference between the rate of increase at Dukinfield and that at Rosebridge, is the effect of the dip of the strata upon the vertical conduction of heat. Laminated rocks conduct heat much better along the planes of lamination than at right angles to them. If k_1 denote the conductivity along, and k_2 the conductivity normal to the planes of lamination, and if these planes are inclined at an angle θ to the horizon, the number of feet per degree of increase downwards correrponding to a given rate of outflow through the surface, will be the same as if the flow were vertical with a vertical conductivity:—

$$k_1 \sin^2 \theta + k_2 \cos^2 \theta.$$

Prof. Herschel finds about 1·3 as the ratio of the two principal conductivities in Loch Rannoch flagstone, and 1·875 as the ratio in Festiniog slate.

The dip of the strata at Dukinfield is stated by Mr. Garside to be 15°, and we have $\sin^2 15^\circ = {·}07$, $\cos^2 15^\circ = {·}93$.

If we assume $k_1 = 1{·}3\, k_2$, as in the case of flagstone, we find for the effective vertical conductivity $k_2\,({·}09 + {·}93) = 1{·}02\, k_2$, so that the number of feet per degree would only be increased by 2 per cent.

It is not likely that the two conductivities in the strata at Dukinfield are so unequal as even in the case of flagstone, so that 2 per cent. is a high estimate of the effect of their dip on the vertical rate of increase so far as pure conduction is concerned. The effect of dip in promoting the percolation of water is a distinct consideration, but the workings of the Dukinfield mines are so dry that this action does not seem to be important.[1]

(*To be continued.*)

METAMORPHIC ROCKS OF BERGEN[2]

THE metamorphic rocks of the Bergen Peninsula in Norway continue to attract the attention of Norwegian geologists, and we have before us, as an addition to the well-known works of Naumann, Leopold von Buch, Esmark, Keilhan, Kjerulf, and Hjörtdal, a new elaborate and interesting work by M. Hans H. Reusch, which deals with the same subject. These rocks consist, as is known, of a variety of quartziferous talc-mica schists, diorite, clay-slates, conglomerates, and strongly-developed gneisses and granites. Various and very different opinions have been expressed as to the origin of these rocks. The researches of M. Reusch give a key to this question, as he has discovered in the clay-slates, which seem to constitute the upper part of these vertical strata, numerous fossils belonging to the lower part of the Upper Silurian formations, namely *Halysites catenularia* and *Cyathophyllum*, changed into white calcareous spar, a few tubular bodies (presumably *Syringophyllum organum*), some gasteropods (*Murchisonia* or *Subulites?*) some trilobites, as *Calymene*, also *Phacops* or *Dalmannites*, and some brachiopods. The presence of these fossils is the more interesting as the whole series of schists was often considered as of igneous origin. As to the gneisses and gneisso-granites of the peninsula, M. Reusch has given great attention to their structure and to the remarkable results of pressure which the rocks have undergone. He shows how granitic veins were folded and crumpled, how a kind of transversal stratification has arisen in beds of stratified gneiss under the influence of pressure, and he concludes, from an accurate study of the subject, that altogether the rocks show a far greater degree of plasticity than might have been supposed. "It seems that there are masses, as, for instance, the gneiss of Svenningdal, that have on one side a true stratified structure (not merely parallel or schistose structure) which could hardly be found in a rock of igneous origin, and on the other side send veins, or have included fragments which have undergone metamorphic changes."

One of the most attractive features of M. Reusch's work is the attention he has given to metamorphic phenomena and to changes caused by the pressure undergone by strata during their folding. The metamorphic phenomena were especially studied in the Osören district. The limestone which contains Silurian fossils has become marble, and the cause of metamorphism was not contact with some eruptive rock, but rather (as was observed in the Bernese Oberland by Swiss geologists) pressure and the molecular movements which pressure has occasioned in rocks. The clay, in which trilobites and other animals were entombed at Vagtdalen, has become a rock like muscovite-schist with porphyritically inclosed clusters of mica. As to the gneiss which appears among undoubtedly Silurian rocks, the author is inclined to consider it as sedimentary and as having been originally formed of loose materials. The granulite is clearly stratified and of sedimentary origin. The changes produced by the folding of strata and by the pressure they have undergone, are described with much accuracy and illustrated by many drawings. The fossils are nearly all compressed and elongated; the formerly conical coralla have received the shape of flat elongated biscuits, in accordance with the direction of pressure and stretching. The same is true with regard to all other fossils. In the green conglomerates at Osören, all the stones are flattened and elongated, acquiring thus a shape which they could not have possessed originally; very many of them have such a shape as to give in a cross-section the form of a lance-shaped leaf. The same structure, remarks the author, may be observed with the aid of a microscope in the "hones" from Eidsmarken in the South of Norway. Altogether the work of M. Reusch, although not rich in conclusions and generalisations, will be a welcome addition to the accurate knowledge of the still little understood metamorphic rocks. The Norwegian text of this work is accompanied with a rather too short *résumé* in English.

P. K.

CHEMICAL NOTES

Carnelley [*Chem. Soc. Jul.* Trans., 1881, p. 317] has repeated his experiments on the effect of pressure on the melting-point of mercuric chloride, and has obtained results which show that this salt cannot be obtained in the solid state at temperatures appreciably above its melting-point.

Jahn [*Berliner Berichte*, xv. p. 1238] has made a series of careful determinations of the density of bromine vapour, which, when compared with similar observations on chlorine made by Ludwig, show that bromine vapour does not attain the normal density (Br = 79·95) until it is heated to 160° above its boiling-point; and also that although chlorine exhibits smaller divergences from the normal density than bromine, it nevertheless

---

[1] Though the workings are dry there is a large quantity of water in the superincumbent strata.

[2] Hans H. Reusch, "Silurfossiler og Pressede Konglomerater i Bergenskifrene."—Universitetsprogramm for förste Halvaar (1883). Kristiania, 1882.

must be heated about 240° above its boiling-point before its density becomes strictly normal. From the experiments of V. Meyer and others, iodine vapour appears to be normal a very few degrees above the boiling-point. It appears, therefore, probable that vapour of chlorine, bromine, or iodine at low temperatures, contains groups of molecules which are dissociated as the temperature rises, and that the greater the molecular weight the more easily are these molecular groups dissociated.

Reference was made in a note (Nature, vol. xxvi. p. 306), to Spring's researches on the expansion of isomorphous compounds; in last number of the *Berliner Berichte* Pettersson draws attention to accurate determinations of the specific gravities of various alums, published by him a few years ago, which proved that the quotients of the specific gravities of the alums by their respective formula weights, are not equal, as assumed by Spring, but show considerable differences. Spring's work on the expansion of alums may lead to interesting results, but it seems evident that he has been too hasty in drawing sweeping conclusions regarding the molecular structure of solids from quite insufficient data.

Herr G. Kruss describes [*Berliner Berichte*, xv. 1243] a spectroscopic method for determining whether there is, or is not, any chemical action occurring in a solution containing two or more coloured salts. The method consists essentially in comparing the sums of the absorption spectra of the individual salts with the absorption spectrum of the solution containing all the salts.

An abstract of an important paper by Mendelejeff on thermochemistry appeared in the *Berichte* for July 10 [xx. 1555]. Mendelejeff asserts that the data hitherto attained by Berthelot, Thomsen, and others, regarding the "heats of formation" of hydrocarbons stand in need of correction, because allowance has not been made for the physical changes, involving absorption or evolution of heat, which in every case accompany the chemical changes considered. Mendelejeff gives a table showing the "heats of formation" from marsh gas, carbon monoxide, and carbon dioxide, of a series of hydrocarbons; the chemical reactions, the thermal equivalents of which are set down in this table, are reactions which actually occur, unlike the reactions of formation of Berthelot and others, which as a rule cannot be realised in actual experiments.

Messrs. Smith and Lowe find that when chlorine is passed through a porcelain tube heated to 1030°, and then into potassium iodide solution, less iodine is liberated than is the case when the same quantity of chlorine is allowed to act on the iodide at ordinary temperature; they conclude, therefore, that chlorine is partly dissociated at a temperature of 1030° (*Chem. News*, xlv. 226).

According to Mixter (*Amer. Chem. J.*, iv. 35), urea is readily obtained by passing ammonia and carbon dioxide through a red-hot tube: ammonium cyanate is probably produced, and then transformed into urea.

Selmi (*R. Acad. dei Lincei*, v. 174) states that he has found alkaloidal compounds having specific poisonous actions in the urine of patients suffering from paralysis, tetanus, &c. He considers death to be determined by the action of these poisons produced by the progress of the disease.

By electrolysing water by a powerful current, using a positive electrode of gas-coke purified by the action of chlorine at a very high temperature, Bartoli and Papasogli (*Gazzetta Chim. Ital.*, 1882, 113) obtained a black solution, which, when acidified with hydrochloric acid, yielded a black substance having the composition $C_{11}H_2O_4$ (when dried at 140°). The properties of this substance—*Mellogen*—are very peculiar; in some points it resembles graphitic acid; it dissolves in water to form an inky-black neutral liquid: on exposure to air or by the action of oxidising agents it yields mellitic acid and other acids, which are generally regarded as addition products of benzene.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

Prof. Bonney begins his course of lectures on Petrology, Physiography, and Stratigraphical Geology at University College, Gower Street, on October 10, at twelve o'clock. The course will extend over two terms. Classes will also be formed for catechetical instruction and for the study of the microscopic structure of rocks.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, September 25.—M. Blanchard in the chair.—A report was given of the ceremony at the recent inauguration of a statue to Antoine-César Becquerel at Châtillon-sur-Loing, on September 24, when addresses were delivered by MM. Cochery, Dumas, Fremy, Mercadier, Barral, and the Mayor.—On a question of principle which relates to the theory of shock of imperfectly elastic bodies, by M. Resal.—Outbreaks of plague in Kurdistan during the last twelve years, by M. Thalozan. The facts are thought to afford further proof of the independence of most of the plague-centres, the small tendency of the disease to spread beyond a small number of localities, and the limited duration of the epidemics, even in their gravest form. The north and north-west of Persia are the parts where plague-epidemics are less rare.—Possibility of introducing a tube into the larynx without producing pain or any reaction, by M. Brown-Séquard. He produces local anæsthesia in mammalia by directing a rapid current of carbonic acid on the upper part of the larynx (through an incision), for a variable time (fifteen seconds to two or three minutes). The effect lasts two to eight minutes after stoppage.—A telegram from the Emperor of Brazil (dated Rio, September 12, 6h. 10m.), announced the observation (at Rio Observatory) of a brilliant comet; estimated position in the morning, ascension 10h., declination 2° S. "probably Pena's comet expected.—On a comet observed at Nice, by MM. Thollon and Gony. This was visible near the sun on September 18, at mid-day, to the naked eye, when the direct solar rays were masked. The spectrum had for essential character the presence of the bright lines of sodium (fine and perfectly separate) in the nucleus and parts near. A slight displacement was held to indicate withdrawal from the earth. No part of the comet showed bands of carbon, nor any band or line but those of sodium (probably because of a masking by diffuse light). On the morning of the 21st the comet had become invisible.—M. Flammarion communicated telegrams from Spain, Portugal, the South of France, Algeria, and Italy, announcing observations of a comet on September 17, 18, and 19.—On an observation of the great comet of 1882, seen from a balloon, by M. de Fonvielle. M. Mallet made the ascent at his request (having keener vision), and took some measurements. The diameter of the comet was about two-tenths of that of the sun, and the distance of the comet's centre from that of the sun about 2·3 subjective diameters of the sun. The cometary sphere was penetrated by an isosceles cone, symmetrically placed to the line of centres, penetrating to two-thirds of its vertical meridian plane. The length of the apothem of the cone was about a solar radius.—Description of a complete regular dodecahedron, by M. Barbier.—On the development of Alcyonarians, by MM. Kowalewsky and Marion.—On the histological structure of the digestive tube of *Holothuria tubulosa*, by M. Sourdan.—Analysis of the milk of Galibi women at the Jardin d'Acclimatation, by Mdme. Brés. The milk is rich in butter and lactose, and there is very little caseïn.

CONTENTS

THURSDAY, OCTOBER 12, 1882

A HISTORY OF COAL MINING

A History of Coal Mining in Great Britain. By Robert L. Galloway, Author of "The Steam-Engine and its Inventors." (London: Macmillan and Co., 1882.)

THIS unpretentious little volume of 273 pages contains a vastly greater amount of information of a useful and varied character than might at first sight be expected, and its author has evidently taken pains to collect the whole of his data from authentic and original sources. He has also succeeded to an eminent degree in welding them together into a concise, clearly written, and intensely interesting narrative. The twenty-three chapters into which the work is divided partly serve the purpose of marking more or less distinct epochs in the history of mining, partly pave the way for introducing accounts of inventions which have owed their origin to its ever-growing necessities. Prominent among these are the railway and the steam-engine, both of which were born and fostered amongst the coal-mines of Great Britain more than a hundred years before they began to revolutionise the world.

It would appear from Mr. Galloway's account that coal first began to be used as a fuel in some localities about the beginning of the thirteenth century. Much objection was raised against its introduction into London on the plea that its smoke was an intolerable nuisance. This opposition was continued for nearly two hundred years in some quarters, but was at last obliged to give way before the growing scarcity of timber. Towards the beginning of the fourteenth century many shallow collieries were opened out in the neighbourhood of Newcastle-on-Tyne, but little is known about the progress of our subject during the course of the fifteenth century. There is enough to show, however, that the demand for coal went on increasing. In a petition presented to the Council by the Company of Brewers in 1578 we find that corporation offering to use wood only in the neighbourhood of Westminster Palace, as they understand that the Queen findeth "herselfe greatley greved and anoyed with the taste and smoke of the sea cooles." Another author writing in 1631 says that "within thirty years last the nice dames of London would not come into any house or room when sea coals were burned, nor willingly eat of the meat that was either sod or roasted with sea coal fire."

Soon after the commencement of the seventeenth century the use of coal for domestic purposes as well as for washing, brewing, dyeing, &c., was general and complete. The mines were still shallow, and they were drained by means of horizontal tunnels called adits, water-gates, &c. Already attempts had been made to sink some of them under the water-level and to raise the water by machinery. In the year 1486-7 the monks of Finchdale Priory expended a sum of money at one of their collieries on the Wear "on the new ordinance of the pump" and on the purchase of horses to work it. Underground fires and noxious gases began also to appear about this time. The miners' tools consisted of a pick, a hammer, a wedge, and a wooden shovel. The coal was raised to the surface in some cases by means of a windlass, in others, as in the mines of the east of Scotland, it was carried up stairs on the backs of women called coal-bearers. In the year 1615 the fleet of vessels called the coal-fleet, which carried the produce of the northern collieries—one-half to London the remainder to other destinations—numbered four hundred sail. Many foreign vessels also, especially French, carried away cargoes of coal to their respective countries. Twenty years later the coal-fleet had increased to six or seven hundred sail, and was already regarded as "a great nursery of seamen."

After the shallower seams were worked out the real difficulties of mining began. It became necessary to deepen the shafts and to greatly enlarge the area worked from each, and both of these circumstances entailed a more or less complete change in the character of the operations. Then it was that the great battle between inventive genius on the one hand and natural forces on the other hand began in earnest. The necessity for an improved means of transporting the minerals gave birth to the railway—probably about the beginning of the seventeenth century.

> "Up till the year 1767 all the railways in the kingdom were constructed wholly of wood, with the exception of the employment of small bands of iron to strengthen the joints of the rails. But wooden rails were liable to rapid deterioration, and the demand for iron at Coalbrookdale happening to be slack in this year, it occurred to Richard Reynolds, one of the partners, that rails of cast-iron might be employed with advantage. A small quantity were accordingly cast as an experiment. They were four inches in breadth, an inch and a quarter in thickness, and four feet in length, and were laid upon and secured to the previously existing wooden rails. They were found to improve the railway so much that the same course was pursued with all the railways at the works. Between this period and the end of the eighteenth century considerable progress was made in the substitution of iron for wood in railway construction."

The inroads of water were first dealt with by means of buckets, then chain-pumps, then ordinary pumps. Horse-power was the common prime-mover, since wind-power was unreliable, and water-power could only be employed under exceptionally favourable circumstances rarely to be met with. As many as fifty horses were employed in raising water at some collieries. At the beginning of the eighteenth century Capt. Savery tried to introduce his fire-engine for raising water, but failed to do so.

> "It was at this juncture" (1710), says our author, "that the miners had put into their hands the most wonderful invention which human ingenuity had yet produced—the Newcomen steam-engine, commonly called the 'atmospheric engine'; a machine capable of draining with ease the deepest mines; applicable anywhere; requiring little or no attention; so docile that its movements might be governed by the strength of a child; so powerful that it could put forth the strength of hundreds of horses; so safe that, to quote the words of a contemporary writer, 'the utmost damage that can come to it is its standing still for want of fire.'"

Towards the end of the seventeenth or beginning of the eighteenth century Sir Humphry Mackworth invented and successfully applied the process of coffering out or damming back water in shafts and sinking pits by means of a water-tight lining now called *tubbing*. He also constructed a railway at his colliery at Neath in Glamorganshire as early as 1698, but after it had been in use for eight years it was declared to be *a nuisance* by the grand jury at Cardiff, and part of it, which crossed the highway between Cardiff and Neath, was torn up and the rails cut in pieces.

Up to the beginning of the eighteenth century the air-currents which ventilated the mines were induced solely by natural causes. It was, however, customary to guide the current into the required channels by means of *stoppings*. As soon as the supply of air was found to be inadequate a new shaft was sunk. Fire-damp was now met with in considerable quantities in the deeper mines, and explosions, which destroyed many lives, began to take place. The first calamity of this kind on the Tyne occurred in 1705, when thirty lives were lost. In 1732 attempts were made in the North of England to produce artificial ventilation by the use of fire-lamps or furnaces, and these appliances were soon afterwards introduced into the collieries of the Tyne. Many disastrous explosions occurred during the eighteenth century and early in the present one, and some remedy was loudly called for. As early as 1733 flint and steel were being used for lighting in the Whitehaven mines, but it appears to be doubtful whether the steel-mill had then been invented. It is certain, however, that it had come into existence in 1753, when its inventor, Spedding, was referred to under the name of Prospero, in a poem in which Dr. Dalton calls it—

> "That strange spark-emitting wheel
> Which, formed by Prospero's magic care,
> Plays harmless in the sulphurous air,
> Without a flame diffuses light,
> And makes the grisly cavern bright."

The steel-mill was at the best a treacherous friend, and our author recounts the various incidents which led to its detection as such, and its abandonment. He also traces minutely the various steps which led to Sir Humphry Davy's splendid invention of the safety lamp in the end of the year 1815, and he gives what appears to be an impartial analysis of the claims put forward by, and on behalf of, George Stephenson to be the original inventor of a similar lamp at the same time.

> "The discovery which Sir Humphry Davy had made, that explosion would not pass through small apertures and tubes, was only a stepping-stone to still higher achievements; and before the close of the year 1815 he gave to the world the *wire-gauze* lamp. This was the last, the most splendid, the crowning triumph of his labours—the 'metallic tissue, permeable to light and air, and impermeable to flame.'"

We must now, however, draw our review to a close without having so much as mentioned many another interesting topic which we hoped to have touched upon—such as the perseverance of Sir Robert Mansell, Vice-Admiral of England, in substituting coal for charcoal in glass making; the romantic struggles of Dud Dudley, son of Lord Dudley, against what seemed to be a relentless fate in his partially successful endeavours to effect the same change in iron making--but we can confidently recommend the reader to the original volume, where he will find much to interest him, much, it may be to profit him, and, we are sure, not a little to amuse him.

GARIEL'S "ELECTRICITY"

Traité Pratique d'Électricité, comprenant les Applications aux Sciences et à l'Industrie. Par C. M. Gariel. (*Premier fascicule.*) 200 pp., 140 figs. (Paris: Octave Doin, 1882.)

M. GARIEL, Professor of Physics at the École des Ponts et Chaussées, and better known in this country as the courteous and energetic secretary of the "Association Française," gives us in the above work the first instalment of an extensive book which will not be completed before next year. This first instalment is introductory to the whole subject, and deals with so much of elementary theory as the author deems requisite to give a firm grasp on his subject. Not rejecting mathematics, the author prefers to keep the mathematical treatment of his subject in the background. Nevertheless, he makes good use of algebraical footnotes, and by these and other evidences it may be judged that a firm scientific grasp will be maintained upon the various branches too often treated in a loose and unscientific manner.

Dismissing at the outset the notion that the work is intended for preparing for examinations, the author chooses from old and new the material that will best serve his purpose. It is very satisfactory to find modern notions, both in electrostatics and in electromagnetics, rapidly taking hold of the leading electricians of France. The treatise of M. Mascart first showed them how far electrostatics had advanced in the hands of Green, Gauss, Faraday, Thomson, Clausius, and Maxwell, beyond the achievements of Coulomb and of Poisson. The text-books of MM. Mascart and Joubert, and of MM. Jamin and Bouty, testify to the extension of this salutary influence. And now in the work of M. Gariel we have evidence of the same progress. For example, M. Gariel breaks free from servitude to the consecrated term "*tension*," so often misused as a synonym for potential, electro-motive force, and we know not what; but he uses it, not however in Maxwell's sense as denoting the mechanical stress along the electric lines of force, but as the electric force outside a closed conductor, or as the equivalent of $-4\pi\rho$. The ideas of Faraday on the nature of statical induction are evidently in M. Gariel's mind, though we think he does not give anything like an adequate attention to the subject of specific inductive capacity, which, though of immense practical importance, is passed over almost without mention. Indeed the faults of the book, if such we may call them in a work of such high scientific accuracy, are faults of omission rather than of commission. The contact-theory of voltaic action is very slightly sketched on p. 107; and on pp. 112–115 there is a discussion of the phenomenon of the variable state (*i.e.* of the gradual rise and fall in the strength of currents at making and breaking circuit), in which all allusion to the self-induction of the circuit is omitted, and which would probably lead a reader to draw the conclusion that the reason why the current did not at once attain its full strength was on account of bad conductivity of some part of the circuit. The portion devoted to Ohm's law is fairly complete; but we think the custom of bringing all resistances to a "reduced length" in the antiquated fashion of Pouillet is better honoured in the breach than in the observance. Amongst the newer topics introduced, and not often found in such treatises, we find Jamin's researches on laminated magnets, the thermo-electric effect discovered by Bouty between a metal and its salt, the so-called internal-current galvanometer of Conrad Cooke, and other matters. Many of the drawings are new and suggestive, though some of them (for example, the Ruhmkorff's coil on p. 189) are not quite on the level of the usual excellence of French scientific illustrations. We have serious fault to find only with one minor point; M. Gariel gives in detail the researches of Wheatstone, Fizeau, and Guillemin on the (supposed) "velocity of electricity," without letting his readers know that the apparent velocity of an electric wave which these observers essayed to determine, is a very different thing from the velocity of electricity itself, to which no man can assign any definite value whatever, and which may be infinite or infinitesimal. We congratulate M. Gariel and wish his work success.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Recent Magnetic Storm and Aurora

THE following particulars of the magnetic storm of October 2, and of the aurora which accompanied it, may be of interest.

At 21h. 40m. G.M.T. on October 1, a sudden disturbance of the magnetic declination and horizontal force commenced, and the motions were rapid, though not exceptionally large, until about 6h. 50m. on October 2, when a large decrease of declination and horizontal force took place. From about 6h. 50m. to 7h. 20m. the declination diminished 1°, and the horizontal force about 1-70th part. The motions were active till 11h., less so till 14h. or 15h., when the disturbance ended. There was much activity between 9h. and 10h.

Both earth-current traces showed a sudden commencement of disturbance at 21h. 40m., just as in the case of the magnetic registers, the times of greatest activity, and the time of cessation of disturbance being also coincident. As is usually the case, earth-currents were more active along the north and south line, than along the east and west.

As regards the aurora, a bright arch extended along the north horizon to an altitude of 20° from 6h. 48m. to 7½h., and remarkable outbursts of streamers were noted from 6¾h. to 7½h., and from 9h. 8m. to 9h. 25m., corresponding closely in point of time with the more active parts of the magnetic disturbance. Patches of phosphorescent light were seen in various parts of the southern sky betweeu 7h. and 7h. 36m., and ruddy light (principally near Arcturus) was observed between 6¾h. and 7½h.

In connection with this magnetic disturbance it is to be remarked that a large spot was on the central meridian of the sun on September 30, having been first seen near the east limb on September 25. It increased considerably in size as it passed across the disc, and its dimensions on September 30 were:—length, 108″; breadth, 65″; area of whole spot (in millionths of the sun's visible hemisphere), 990; of umbra, 215. There was a line of smaller spots following it 128″ in length, with an area of 520, and a spot of considerable size near the equator, forming, on October 1, with the large spot, three spots visible to the naked eye. The large spot was nearly in the same position on the sun's surface as the great spot of last April, its heliographic longitude being 51°, and latitude 22° S., whilst the position of the great spot on April 10 was long. 65°, lat. 29° S., and at its next return long. 52°, lat. 29° S. W. H. M. CHRISTIE

Royal Observatory, Greenwich, October 9

AN aurora of unusual form appeared here this evening at 7.8 p.m. My attention was attracted by a patch of light in the south-west about 10° above the horizon, and about 6° in diameter. On looking to the north, I saw the usual streamers and bright light indicating an aurora; presently another patch of light, similar to the first, appeared in the south-east, and then others between these two, forming a continuous arch lying, as near as I could judge, in the diurnal path of the sun in mid-winter. The arch had a sharp outline below, and from the brightest portion of it extended short streamers, towards the zenith; the colour was a greenish white. In a few minutes the continuous arch disappeared, leaving the brightest portions, which disappeared and reappeared alternately in patches until 7.40, when the last rather suddenly died out.

The light in the north was not particularly bright, nor were the streamers so continuous or numerous as usual, but that in the south showed up most brilliantly against the black sky near the horizon, so much so that the appearance was as if a dark cloud of circular outline was coming up from the south, and cutting off the lower portions of the auroral light. GEO. M. SEABROKE

Temple Observatory, Rugby, October 2

THE aurora of Monday, the 2nd instant, was succeeded by another on the following night at 11 p.m. It assumed the form of pale streamers issuing from a point in the horizon about north by east, and uniting in a similar way directly opposite in the south, like the meridian lines marked on a globe. The streamer crossing the zenith was the brightest. A. PERCY SMITH

Temple Observatory, Rngby, October 6

THE communication below is from a lady. I was on the road from Hilton to this town (and several miles distant from the residence of my correspondent), when I observed the great display she alludes to. I also saw the white clouds or nodes, and at the moment I thought it was a lunar rainbow, similar to one I described in vol. xx. of British Association Reports (1850), but upon considering that the moon had not then risen, and turning round I saw the grand appearance.

St. Ives, Hunts., October 6. J. KING WATTS

A most splendid and beautiful aurora borealis was visible for a long time yesterday evening, October 2 in this town, commencing at 6h. 40m. The weather had been precarious all day. In the early morning there was a thick white fog, the wind being south-west. The wind afterwards changed from that point to the north-east, then in the afternoon to the north. The sky had been much overcast, and some slight showers of rain fell at intervals. The wind then suddenly changed to the west, for a short time, and then back to the north, gently driving the clouds away to the south-east. The aurora then became visible, and was most gorgeous and brilliant, throwing up incessantly various coloured streamers, and many flashes of white light, which passed several degrees beyond the zenith. When the moon arose shortly after 9 p.m. the appearance was still in existence, and was very singular and impressive. During the display and until the aurora had finally disappeared, two large white clouds or nodes were visible, one being similar to a large lump, and the other streaming, and of great brilliancy, in the opposite direction, and they continued so for some time after the aurora had finally disappeared. ANNE GIFFORD

Over Cambs., October 3

I SEE in NATURE (p. 548) notices of an unusual aurora that was seen on the evening of October 2. The following observation may be of interest. At 5.30 p.m. that evening, while it was still quite light, I noticed a band of "mare's tail" cirrus extending from the horizon about north-east, through the zenith, to the horizon about south-west; the texture of the cloud—which I may mention somewhat resembled the backbone of a fish—indicated that it was one of the highest sorts of cirrus. The sky at that time was unusually clear of other cirri; and this rib attracted my attention by its unusual length in isolation. Perhaps further observations may tend to show that these high clouds owe something of their arrangement to electrical causes.

Cheltenham, October 6 W. LARDEN

IT may be worth mentioning that the aurora on the evening of the 2nd inst. was observed at sea on board the Guion s.s. *Arizona* in about Lat. 51° N. and Long. 28° W., or about 700 miles west of Cape Clear. I first noticed it soon after 7 p.m. (ship's time), but the most brilliant display which I saw was between 12 and 12.15 p.m. (G.M.T.), when sheets of light resembling the folds of a curtain passed rapidly across the northern sky. The light was colourless, with occasional flashes of crimson.

H. MELLISH

Hodsock Priory, October 9

Newton, Wollaston, and Fraunhofer's Lines

IN most of the current treatises on spectrum analysis, on the spectroscope, and on optics generally (Lloyd's works being exceptions), injustice is done to Newton's care, and scientific insight in his optical experiments, when Wollaston's discovery of the dark lines in the solar spectrum is alluded to, by most positive statements to the effect that Newton never used the slit, or that Wollaston was the first who ever made observations on the pure spectrum.

That the statements are erroneous may be seen by a comparison of the following extracts from Wollaston's paper in the *Philosophical Transactions* for 1802, p. 378, and Newton's "Opticks" edition of 1704.

Wollaston concludes from his experiments that "the colours into which a beam of white light is separable by refraction, appear to me neither 7, as they usually are seen in the rainbow, nor reducible by any means (that I can find) to 3, as some persons have conceived, but that by employing a very narrow pencil of light, four primary divisions of the prismatic spectrum may be seen with a degree of distinctness, that, I believe, has not been described nor observed before." He describes the experiment as follows:—

"If a beam of daylight be admitted into a dark room by *a crevice* 1·20*th of an inch broad*, and received by the eye at a distance of 10 or 12 feet, through a prism of flint glass *free from veins* [italicised by Wollaston], held near the eye, the beam is seen to be separated into the four following colours only, red, yellowish, green, blue, and violet." He then describes four lines marking these divisions, together with two others for which he does not offer any explanation.

Compare with this Prop. 4 of Book I. of the "Opticks," which is "To separate from one another the heterogeneous rays of compound light." Newton, after showing at some length why he uses a lens to "diminish the mixture of the rays," describes Experiment 11, p. 47, as follows:—

"In the sun's light let into my darkened chamber through a small round hole in my window-shutter, at about ten or twelve feet from the window, I placed a lens, by which the image of the hole might be distinctly cast upon a sheet of white paper. . . . Then immediately after the lens I placed a prism, by which the trajected light might be refracted either upwards or sideways." The "oblong image" thus formed he received upon paper placed "at the just distance where the rectilinear sides of the image became most distinct." By varying the size of the hole, he made "the mixture of the rays in the image to be as much or as little as I desired." For this purpose he caused the breadth of the image to be sometimes sixty or seventy times less than its length.

"Yet *instead of the circular hole, 'tis better to substitute an oblong hole shaped like a long parallelogram, with its length parallel to the prism.* For if this hole be an inch or two long, and *but a tenth or twentieth part of an inch broad or narrower;* the light of the image will be as simple as before, or simpler, and the image will become much broader, and therefore more fit to have experiments tried in its light than before."

For the purpose of comparing the simpler light with the more compound, he used also a hole of the shape of an isosceles triangle, whose base was "about the tenth part of an inch, and its height an inch or more" (the width of which, therefore, at a quarter of an inch from the vertex, would be one-fortieth of an inch). The refracting edge of the prism was parallel to the perpendicular of the triangle. The images would therefore be "equicrural triangles," "a little intermingled at their bases, but not at their vertices."

He is very emphatic as to the precautions in making the experiments. He was always careful to have the image in the position of minimum deviation—all foreign light must be carefully excluded from the chamber. The lens must be good—the prism being made of "*glass free from bubbles and veins,*" with its sides truly plane and its polish elaborate." "The edges also of the prism and lens, so far as they make any irregular refraction, must be covered with a black paper glued on." "It's difficult to get glass prisms fit for this purpose."

He did not, as is sometimes supposed, always receive the images on paper, for in Expt. 4, Prop. ii., p. 22, he says: "I looked through the prism upon the hole."

That with good prisms, and the great variety of experiments which he must have tried, he did not see the dark lines by looking through the prisms, seems remarkable. It may possibly be explained by the fact that in the very class of experiments in which he was most likely to discover the lines (and in which Wollaston actually discovered them), he found himself obliged to rely on the observation of an assistant. This is mentioned on p. 92 in Prop. iii. of the second part of Book I. The proposition is "To define the refrangibility of the several sorts of homogeneal light, answering to the several colours." In this he says: "I delineated therefore in a paper the perimeter of the spectrum" . . . "and held the paper so that the spectrum might fall upon this delineated figure, and agree with it exactly, *whilst an assistant, whose eyes for distinguishing colours were more critical than mine*, did by right lines drawn across the spectrum note the confines of the colours."

ALEXANDER JOHNSON

McGill College, Montreal, Canada, September 19

The Spectroscope and Weather Forecasting

I MUCH regret that Prof. Smyth should have taken the word prognostic, applied to the rain-band as a depreciatory epithet, when it was only intended as a term of classification. In common parlance any particular "look" of the sky is called a prognostic, and it is a natural extension of the idea to call the "look" of the sky absorption a spectrum prognostic also.

The question at issue is this. Assuming that the rain-band is a quantitative measure of the amount of vapour in a section of the atmosphere, why is it of more use in forecasting than the numerous sky and other prognostics which also indicate an excessive amount of vapour, as, for instance, sweating walls, or a soft sky. Like them, it precedes rain in certain cases, and for the same reason; like them, it fails in numerous cases where rain falls without being preceded by excessive vapour quantity; and, like them, it cannot compare in forecasting value with synoptic observations over a large area, which correlate moist currents with isobaric lines.

But there is one case in which the rain-band may give valuable information—when we have a vapour-laden upper current over a dry surface wind. This often occurs in winter, with a warm south-west current over an area of frost and an east wind. In practice this almost invariably makes itself visible by the long converging stripes of cirrus which so often precede a rainy thaw, but still cases may occur when no cirrus is formed, or it is otherwise invisible. Here is a case in point. One spring morning in London there was a thick fog, with a south-west wind. About 1 a.m. the wind shifted to east, the pavement remaining white and dry; when, to my surprise, the ordinary spectrum of a fog was crossed by a strong rain-band. Two hours afterwards a few big drops of rain fell, which soon ceased, and the wind returned to the south-west.

The 8 a.m. chart showed London to be then on the northern edge of an anticyclone, with a small secondary cyclone over Devonshire; this moved on during the day, bringing rain with it, which soon passed.

We can now estimate the different values of the several indications. Cirrus, if there is any, tells that a moist south-west upper current has set in, but not if it is specially vapour-laden.

The rain-band tells us simply that there is an abnormal amount of vapour somewhere, and roughly measures it; by inference, from the dryness of the ground, we know that the vapour must be overhead; in very rare cases the band would speak before the cirrus, and in any case would show unusual vapour, which the cirrus could only suggest by looking softer than usual. On the other band, the spectroscope would be silent in numberless cases where cirrus would indicate rain correctly, and neither could tell their story till the vapour-bearing current had set in.

The forecaster, who used synoptic charts, would know that a damp south-west wind always blew over the north-east wind in front of a cyclone, and in a case like this could say that as the secondary approached, the moist upper current would set in some hours before it arrived, and would be so far ahead of any prognostic; but he would have no means of saying if the current was extra vapour-laden or not.

But in most cases a knowledge of the fact would be but of little service to him. Suppose that in this case there was rain at Plymouth, cirrus or rain-band at Portsmouth, and blue sky over fog in London, the knowledge of this rain-band would not help him much, for he knows by his chart that rain has already set in.

What he does want to know is whether the cyclone will move northwards, eastwards, or southwards. This no prognostic can tell him; the only known clue to a cyclone path is got from a knowledge of the movements of isobaric lines. In this instance the rain in London was, I think, correctly forecast, but unfortunately such a simple case rarely occurs in this country.

Thus we see that a knowledge of the amount of moisture in any current is of only secondary importance to synoptic forecasting, so that if we may welcome the rainband as an addition to our old stock of prognostics, there is little ground for hoping that it will be of further service than them.

All that Prof. Smyth claims for the spectroscope is to act as a gauge of pure vapour quantity, but it seems probable that its employment may be still further extended. There are strong grounds for believing that an air spectrum may vary not only with the amount of pure vapour, but also with the size, aggregation, and physical condition of the condensed vapour suspended in it. For instance, take the so-called rain lines. These may appear either alone, or with a rain-band of any intensity; so that if the band is due to pure vapour only, the lines must depend on some other condition Again in sunset tints we have a natural spectroscope whose colours certainly are the product of both the quantity and quality of the total moisture suspended in the air. I have made a large number of observations on the lurid, coppery, yellow, green, and red skies, which form such a large portion of all weather lore, but without decisive results; for sunset spectra are too complicated and too fleeting to be unravelled by a small instrument. They certainly seem to differ, but their spectra are not so marked as their appearance to the naked eye.

But even supposing that this idea is completely verified, and that the spectroscope can be used as a new weapon of research to discover the still unknown nature of clouds, and that we are ever able to say that such and such an absorption spectrum belongs to such and such a kind of sky, there are no grounds for believing that we can ever regard these spectra otherwise than as a new set of sky prognostics, or that as such they will be of more use in forecasting than those already known.

What the use of any prognostics is in forecasting, and how they are related to synoptic charts, and how isobaric lines map out the shape of rain areas, are other sides of the great problem of weather forecasting, which cannot be discussed here.

Some may differ from Prof. Smythe as to the forecasting value of the rain-band, but all will appreciate the singular skill with which he has surmounted the practical difficulties in the way of making it a quantitative measure of atmospheric vapour.

21, Chapel Street, S.W. October 2 RALPH ABERCROMBY

The Comet

WHEN observing the comet this morning, with 7½ inch aperture and powers of 70 and 150, I at once noticed that the nucleus was far from circular, the length being carefully estimated at 45″ and the breadth at 15, while the measured "Position" of the maj. axis was (96°–276°); this was also the supposed direction of the tail, which had ceased to be visible in the increasing twilight.

At 6h. 0m. G.M.T. the place of the comet was

$$\text{R.A.} = 10\text{h. } 27\text{m. } 3 \pm 5 \text{ secs.}$$
$$\text{N.P.D.} = 100^\circ\ 36'\ 30'' \pm 10''.$$

These places, taken with the equatorial, were confirmed by measures of the not far distant star α Leonis. They differ considerably from the calculated place given in the Dunecht Circular, No. 60. WENTWORTH ERCK

Sherrington House, Bray, Co. Wicklow, October 9

"Note on the History of Optical Glass"

THE writer of the article in a recent number of your journal, entitled "Note on the History of Optical Glass," has fallen into some historical blunders and anachronisms, which are the ground of my addressing you. My grandfather was born in 1738, and would therefore have been but twenty years of age at the date when he is said to have made the acquaintance of the elder Guinand, then sixteen, in Switzerland. It is almost certain that he never was there, at any rate not as an "illustrious savant," engaged in telescopic experiments. His sister's memoirs present a blank at this exact date, but it is evident that if he travelled at the time when he withdrew from the Hanoverian military service, it was in the character of an obscure young musician. It is just barely possible that there may be some foundation for the story now given—and if so, I should be glad to learn it—but a totally mistaken colour has been given to it by drawing on the future. What follows is still more erroneous. Dollond (the elder) was at this period at the zenith of his fame as an optician; Faraday was not born, and Herschel was an ex-bandsman; yet we are told that he "returned the following year with Dollond and Faraday." It is probably something more than a mere coincidence that about sixty years later the son of that Herschel, the son of that Dollond, and Faraday, were associated in treating with the son of that Guinand for the glasses manufactured by the latter. Apart from this, I submit that hardly anything new is contributed in the "Note." All, and more than all, which it contains will be found in the *Biographie Universelle*, under the name GUINAND, where also is mentioned the Swiss rencontre, but with the name *Droz* in lieu of "Herschel and Utzschneider." According to the *Biographie*, Guinand was born "about 1745," and died in 1825. It was in 1821 that the Astronomical Society was instigated to make inquiries (conducted by my father) regarding Guinand's optical glasses. J. HERSCHEL

A "Natural" Experiment in Complementary Colours

ABOUT two miles above Ormeim, in the Romsdal (Norway) is the well-known Slettafos, an imposing cascade formed by the impetuous Rauma, which here plunges through a deep rocky ravine. Fascinated by the scene, I stood watching the foaming water for some time, and all at once noticed a most beautiful and delicate rosy pink tint colouring the foam and spray in the ravine. The water, where not broken up, was of a green colour, and the pink tint was at once explained as its complementary. But the point of special interest to me was that this pink colour was not visible except on those parts of the spray and foam which were in the shade of the gorge. In the full light these appeared, as usual, white. The result above described is an excellent illustration, afforded by nature herself, of the advantage of toning down the brightness of the white surface, upon which we wish to evoke a complementary tint, until it no longer exceeds that of the exciting colour—the green in this case.

CHAS. T. WHITMELL
H.M. Inspector of Schools

9, Beech Grove, Harrogate, September 11

Animal Intelligence

IN the article on animal intelligence [(NATURE, vol. xxvi. p. 523), Mr. Morgan seems to me to have inverted the real process in the case of what he calls "isolation," for he says: "I believe such abstract ideas to be impossible for the brute. I believe them to be the outcome of the use of language." The process of abstraction here alluded to is the conception of a quality apart from the things that possess that quality, as whiteness or edibility.

I watched a little child just able to walk alone, on a railway platform. It went up to a square box, and after staring at it for a few seconds, slowly passed its hand over the top, front and sides, and then along the edge, clearly testing the sense of sight by that of touch. It then did the same with the small wheel of a luggage barrow. It was obviously too young to be able to speak, but I think we may safely assume that it got a notion of what we call "square" and "round." Now a dog can readily acquire a somewhat similar experience, by finding a barrel to be less easy to stand upon than a square box. So far they are much alike; the child, however, certainly exhibited a greater inquisitiveness than a dog is likely to do.

It is obvious that a dog can receive just the same impressions as a child through the senses, so that automatic appreciation of the difference between roundness and squareness is common to both; but, whereas, the dog, as I believe with Mr. Morgan can never get beyond that stage, a child, if not an infant, can make the difference an *object of thought* or a mental abstraction, even without having a word to express it; just as an adult experiencing a new but uncomfortable sensation, can think of it, and coin a term to express it, say, "all-overish-ness;" or again, as one can *feel* indignant or benevolent, and at the same time think about such states without necessarily giving expression to them. If words were necessary, as Mr. Morgan seems to think, then a deaf-mute, who had never been taught to speak, could never rise higher than a brute, because he cannot *picture* "justice" or "edibility." But if we recognise the power to abstract the conception of roundness, justice, edibility, &c., *then* can be felt the want of symbols to represent them; just as a concrete thing, say, a tree, needs the word "tree" to stand for it. Instead, therefore, of considering abstract ideas as an "attempt to conceive a reality-in-thought answering to certain of our symbols," I would completely reverse the process, and make speech itself as the outcome of our power of making abstractions *objects of thought*, *i.e.* not only can we be conscious of what is white, as a dog also can, but we, and we alone, can be conscious of whiteness; and just as the symbol "white" is invented to stand for the concrete, so "whiteness" is the symbol invented to stand for the abstract. GEORGE HENSLOW

Drayton House, Ealing

An Insect Attacking a Worm

MR. E. LAWRENCE's letter in this week's NATURE reminds me that, walking, now many years ago, on a very hot and bright summer's day, I saw a huge earthworm crawling across the hard-beaten and sun-baked highway. What has brought *you* forth at such a time? I asked, and speedily got my answer. For, coming nearer, I found the larva of some beetle holding on obstinately by the poor worm's tail. I had not leisure to wait the result; and indeed, although here memory does not help me, I may have interfered on behalf of the worm, and so failed to witness anything corresponding to Mr. Lawrence's interesting experiences.

Even although such encounters as that witnessed by him may be but rarely visible, I venture to believe that earthworms very often fall victims to predaceous larvæ. Those of the Caribidæ and other predacious beetles are common enough, that of the well-known ferocious being, the "rove-beetle" (*Staphylinus olens*), for example. The singular pointed tail-appendage of its larva, supposed to assist locomotion, may have a more important use. Turned to an acute angle with the body, it may effectually help the larva to hold its place in a worm-hole against the efforts of its prey to escape from its jaws. And only when the captured worm is very powerful may it be able to come to the surface of the ground, dragging its relentless foe along with it. Such, indeed, was the worm I saw, which had thriven well in the rich meadow-land bordering the Portobello Road, near Edinburgh, copiously irrigated with town sewage, and famous for its fertility. It was the largest I remember ever to have seen, to the best of my belief at the time not less than a foot long, while its assailant might be about an inch only, more or less WILLIAM SWAN

Ardchapel, Dumbartonshire, October 6

YOUR correspondent, Mr. Edwin Lawrence, is mistaken in supposing that the worms of England enjoy immunity from attacks such as he witnessed at Laqueville. I saw, in North Devonshire, in the last week of July, 1882, an incident precisely like that which he narrates. The insect I should judge from his description was identical. What particularly impressed me was its enormous strength, for the earth-worm, which was a large specimen of its kind, must have had at least twenty times the bulk of its adversary, and yet the insect, seizing upon the middle of the body, dragged it by main force a distance of three or four inches. It was cunning as well as strong; for when it found that the corpse, dragged loopwise from the middle, met with considerable resistance from the stiff wiry grass, it seized hold of the head, brought it round over the middle, and endeavoured to drag the worm lengthwise between the opposing stalks. I watched the attack for some time, and then removed the insect with my stick to a distance to see if it would find out the worm again, but in doing so I unfortunately injured it. When I first saw it the worm could still crawl, though feebly, but at the end of the attack it was quite motionless. HERBERT RIX

Science Club, Savile Row, W.

MR. WALLACE, of Tynron, Dumfriesshire, related to me an incident which he was witness to, a few months ago, so similar to that related by your correspondent, Mr. Lawrence, that I called his attention to the communication of the latter. The worm Mr. Wallace observed, was attacked by the same kind of caterpillar-like animal, the difference being that after much twisting and wriggling, about two-thirds of the worm broke away and escaped, leaving one-third in the enemy's possession, upon which it seemed to settle down for the purpose of a meal.

J. SHAW

Chiasmodon Niger and Notacanthus Rissoanus

IF the "singular fish of a deep black colour, with small eyes, and a most *abyssal* physiognomy," noticed by Prof. Giglioli (NATURE, vol. xxv. p. 535) had been a *Chiasmodon*, that learned ichthyologist would doubtless have recognised it, and not suggested that "it may be allied to *Malacosteus*." But in addition to the two specimens of *Chiasmodon niger* referred to by Mr. Johnson (NATURE, vol. xxvi. p. 453), it may interest ichthyologists to learn that a third specimen has been found off the New England coast (on the Le Have Bank). Like the others previously known it had engorged a fish several times larger than itself. The specimen is now in the U.S. National Museum. *Chiasmodon*, it may be added, is not at all related to the Gadidæ, as has been supposed by Messrs. Günther and Johnson, but is a true Acanthopterygian fish and the type of a peculiar family—the *Chiasmodontidæ*. [In Dr. Günther's "system" it belongs to the heterogeneous family *Trachinidæ*.]

With respect to the *Notacanthus rissoanus*, for which a new generic name has been proposed by Prof. Giglioli, permit me to state that prior designations have been suggested. In fact the genus has now received five names, viz.: (1) *Campylodon*, Günther, prov. name, 1861 (not of Fabricius, 1878, and not defined); (2) *Polyacanthonotus*, Bleeker, 1875; (3) *Zanotacanthus*, Gill, 1876; (4) *Paradoxichthys*, Giglioli, 1882; and (5) *Teratichthys*, prov. name Giglioli, 1882. THEO. GILL

Smithsonian Institution, Washington, September 18

PROFESSOR HAECKEL IN CEYLON[1]

VI.

IN his walks through the Singhalese village, of which he preserves so many pleasant memories, Prof. Haeckel was particularly struck with the comparative rarity of the weaker sex, especially of girls between 12 and 20 years of age.

"The greater number of children playing in the streets were boys. Girls are early accustomed to remain inside the huts and employ themselves in household work. Besides this, they develop very young, being often married at 10 or 12 years old, and old women at 20 or 30. Grandmothers of 25 to 30 are very frequent. A further significant fact is the permanent disproportion of male and female births among the Singhalese. The average is 10 boys to 8-9 girls. This fact is connected, to some extent at least, with the curious institution of polyandry. In spite of the efforts made by the English Government to suppress this custom, it maintains its ground, especially in the more remote districts of the Island. It is not unusual to find two or three brothers with one wife in common, and ladies may be found the happy possessors of 10 or 12 husbands. These complicated family arrangements form the theme of many extraordinary stories; but it is very difficult to distinguish fact from fable on the subject. . . .

"The Singhalese have a passion for music and dancing, and practise both arts according to a standard of taste very different from our own. Their principal instruments are the drum and the tom-tom, vigorously belaboured with wooden drum-sticks; besides these, they have reed-pipes, and a very primitive stringed instrument of one string. My evening calm was often broken in upon by the din of these ear-splitting instruments, and if I followed the sound to its source I was sure to find, in front of a fire under a palm tree, a group of ten or a dozen naked brown fellows, gaily painted with white, yellow, or red stripes, and indulging in the most extraordinary antics. A circle of spectators stood round, and followed the grotesque performance with devout attention.

"At Christmas time (the Buddhist New Year) these evening 'devil-dances' are more frequent, and partake

---

[1] Continued from p. 503.

somewhat of the nature of a religious ceremony. The principal performers are fantastically adorned with coloured feathers and decked with horns and a long tail, to the immense delight of the youthful portion of their audience. Whole troops of these demons parade the village with musical accompaniments throughout the day, the nightly revels being sometimes extended into somewhat unseemly orgies.

"The chief of the neighbouring village, Dena-Pitya, organised a special Buddhist festival on December 19, to which I was invited as the guest of honour, and escorted in grand procession. Ten or twelve old close-shaven priests of Buddha in yellow robes received me under the shade of a gigantic sacred fig tree, and led me to the sound of marvellous singing within the flower-decked temple. Here I was shown the great image of Buddha and the wall-paintings (scenes from the life of the God) were explained to me. Then I was conducted to a chair of state placed under the shade of a banana in front of the temple, and the actual performance began. A band of five tom-tom beaters and as many pipers set up a noise which would have wakened the dead. Then two dancers upon stilts executed a series of wonderful evolutions. While they were proceeding, the chief's daughters, well-grown, black-haired girls of from 12 to 20 years of age, offered cocoa-nut shells filled with toddy or palm wine, and sweetmeats and fruits for refreshment. A long speech was addressed to me by the priest of which, unfortunately, I did not understand a word; but I imagined the subject of it to be the honour which I had done him by my visit. The same idea was pantomimically expressed by a band of ten naked, painted, and bedizened devil-dancers, jumping and whirling round my throne like madmen. When I was at last permitted to break up the sitting and return to my bullock-cart, I found it full of the finest bananas and cocoa-nuts placed there as a parting present from my friendly entertainers. . . .

. . . "One of the most lovely of the coast lagoons (or *gobbs*) within an easy distance of Belligam, is that called Boralu-Wewa. I am indebted for the pleasant days I spent there to my good friend the Arachy, or second headman of Belligam. He owned a large tract of land close to the lake, planted partly with different fruits, partly with lemon grass, on which he employed from 30 to 40 labourers. The road to Boralu turns off before Dena Pitya, in a north-easterly direction, now passing through lovely palm woods or luxuriant jungle, then across light green paddy fields or marshy meadows, where black buffaloes lie in the mud, and pretty white herons seek their prey. After several miles of this, we come to the lovely lagoon of Boralu, the road sometimes skirting its shores, sometimes making wide detours. The banks are covered with the most luxuriant vegetation, and the background is composed of thickly-wooded hills. A little island covered with trees lies solitary in the midst of the lake. The numerous tongues of land projecting from the shore far into the water give a peculiarly varied charm to the scene; but its principal attraction lies in its intense loneliness and the entire absence of human cultivation. The impression is not destroyed by the carriage-road along the shore, for this is quite concealed by a thick growth of shrubs on either side. The lagoon and its vicinity are rich in animal life. I never visited it without finding the great green lizard (*Hydrosaurus salvator*) six or seven feet long, sunning itself on the banks, and once I was startled by a huge serpent twenty feet long (*Python molurus*). Unfortunately the monster slipped off the rocks into the water before I could take aim at him. A more exciting chase was afforded by the apes, whose chatter was to be heard on every side. I shot several fine examples of the yellow-brown 'Rilawa' (*Macacus sinicus*) and of the great black 'Wanderu' (*Presbytis cephalopterus*). But swimming birds were more enticing still to the sportsman, and I secured many species of water-hens, herons, ibis, flamingoes, pelicans, &c. They came flying over the lagoon in large flocks towards sundown, seeking their nightly quarters; I once brought down half a dozen in a quarter of an hour. The thick brushwood of the banks, with its lovely golden cup-shaped cassia-flowers and purple melastoma, harbours many smaller birds. . . . Besides birds, apes, bats, lizards, &c., I once shot a great porcupine more than three feet long (*Hystrix leucura*). Butterflies and beetles also abound in great varieties. The marshy meadows near the lagoon are often covered with gigantic examples of insectivorous pitcher-plants (*Nepenthes distillatoria*). The elegant pitchers, six inches long, covered with a closely-fitting lid, were sometimes full of captive insects. Brilliant-hued *Ampelidæ* and lovely honey-suckers (*Nectariniæ*) sport among the blossoms with the humming-birds that they resemble. . . . A saunter round the lake leads through the most beautiful part of the forest. In some places the tangle of creepers, *Aristolochia*, *piperacea*, wild vines and pepper plants, *bauhiniæ* and *bignonia*, are so intertwined among the branches of the trees that only a few gleams of light can straggle through them, and no progress is possible without the aid of the knife at every step. I often sat for hours with my sketch-book open before me trying to seize one of these forest views; but I scarcely ever succeeded, owing to the difficulty of knowing where to begin; or when I had begun, how to reproduce such bewildering luxuriance of foliage. The Arachy cultivated lemon grass upon the rounded hills that surrounded his garden; from this very dry grass a simple process of distillation extracts a fragrant and much prized perfume. The whole neighbourhood is penetrated with the scent. The workmen who are occupied with the distillation and with the cultivation of the bananas live in about a dozen scattered huts clustered under the shade of bread-fruit and jak trees; groups of slender areca and cocoa palms, with here and there kittuls and talipats spreading their feathery crowns high over the level of the forest mass, betray the hiding-place of the little bamboo huts. My visits to them, and my intercourse with their friendly inhabitants taught me almost to envy their simple and natural mode of existence. They are all pure Singhalese, cinnamon-coloured and delicately formed; their clothing is limited to a narrow white cloth round the loins. The bright pretty boys were eagerly glad to help me in collecting birds and insects, while the graceful black-eyed girls twined garlands and adorned my ox cart with flowers. At evening time, when the swift-footed bullocks had been harnessed to the cart, and I had taken my place by the Arachy, our rapid start was a special delight to the children, and as we rolled along the lovely banks of the lagoon we were usually followed by a swarm of twenty or thirty gay little creatures, shouting and waving palm leaves, or pelting us with flowers. . . .

"The most distant excursion that I undertook from Belligam at the close of my stay there was to the southernmost point of Ceylon, the far-famed Dondera Head. The town of Matura lies a couple of miles to the west on the shores of the Blue Sand river (Nilwella Ganga). The road from Belligam to Matura is the continuation of the lovely avenue of palm trees which leads from Galla to Belligam, and affords the same variety of luxuriant and beautiful scenery. Arrived at Matura, a town which has lost much of its prosperity since the time of the Dutch dominion in Ceylon, I refreshed myself with a cold bath and did ample justice to the English luncheon provided by my friends. Thus fortified I determined to lose no time in setting off on the proposed expedition, in company with the chief Ilaugakuhn, the most distinguished Singhalese on the whole island. He is, in fact, the last male descendant of the ancient line of Kings of Candy, and resides in a handsome palace at Matura, near the mouth of the river. A month previously he had paid me a visit at Belligam, and presented me with several rare and beautiful birds.

My visit to Matura was made at his request, and the reception he gave me was kind and flattering in the extreme. He insisted on driving me to Dondera. His carriage, a well-appointed English phæton, was drawn by two fine horses of Australian breed. A handsome black Tamil in a red turban and silver-laced livery, ran before us all the way. . . .

"The long blue peninsula of Dondera Head, with its forests of cocoa palms, is visible on the road from Matura long before it is reached. It is the most southerly point of Ceylon, lying at 5° 56′ N. latitude. For more than 2000 years the temples erected on this spot have been the object of pilgrimages, only second in fame to those to Adam's Peak. Thousands of pilgrims and devotees flock here every year, and the temples have been dedicated alternately to Buddha or Vishnu, according as the native Singhalese or the Malabar invaders had the upper hand. Three hundred years ago, the chief temple was an Indian building of the first rank, so large, that from the sea it appeared a considerable town; its numerous pillars and statues were richly decorated with gold and precious stones. In 1587 all this magnificence was destroyed by the Portuguese, who carried off the rich spoils of the interior of the temple. The enormous extent of the building may be estimated by the ruins which remain. In one corner a very large Dagoba has been left standing close to several ancient and colossal Bo-gas or sacred fig-trees. The ruins of a smaller temple are to be seen on the narrow tongue of land which forms the extreme southern point of Dondera Cape. They consist of octagon pillars of porphyry, rising in lonely desolation from the granite rock, and washed by the foaming surf which surrounds it. At low tide I collected many curious marine animals in the natural basins among these rocks, and sat for a long time lost in thought upon this, the most southerly point I had ever reached. It was late in the evening before we returned to Matura. The following day (January 19) was dedicated to a long marine excursion. The chief, Ilaugakuhn, had placed a capital sailing canoe at my service, and my trip extended a long way to the south of Dondera Head. It was glorious summer weather, and the north-west monsoon blew so strong that it was all my boatmen could do to keep the canoe from capsizing. Our speed was almost equal to that of a powerful steamer. No better illustration could have been found of the ease with which the narrow Singhalese canoes cut through the waves, or rather, glide over their crests. As the island receded from our gaze, we had a lovely view of the blue mountain masses, crowned by Adam's Peak, rising from the palm forests of the plains.

"After about four hours of this rapid sailing we became aware of a broad bright streak on the surface of the ocean, extending in the direction of the monsoon, from north-west to south-east, and about a mile wide. I pronounced it at once to be a pelagic stream or current, one of those narrow ocean rivers which frequently occur both in the Ocean and the Mediterranean Sea, and which owe their origin to the amalgamation of huge shoals of marine animals. As we drew nearer, my surmise proved correct, and I was rewarded with an extraordinarily abundant and interesting capture. A dense mass of pelagic animals, in endless variety, besides numerous larvæ of worms, star-fish, crabs, molluscs, &c., swam hither and hither, and all the vessels I had with me were speedily filled. I only regretted not to have brought enough to contain specimens of all these zoological treasures, among which were many rare and hitherto undescribed varieties. I returned to Matura late in the evening, richly laden with booty, which would provide me with interesting work for many years to come. It was a pleasant reminiscence of the fifth degree of north latitude. My Singhalese were so skilful in taking advantage of the monsoon, that we returned almost as quickly as we had gone, and landed safely at the mouth of the River Nilwella. The view of this delta from the sea is very picturesque, and both banks of the river are thickly wooded. I went up the stream in a canoe on the next day, and was filled with fresh wonder at the unexampled luxuriance of the forest vegetation.

"A melancholy task awaited me on my return to Belligam. I had to bid farewell to the spot on which I had spent six of the happiest and most interesting weeks of my life. The impression of this parting is as vivid in my mind as if it were still to come. The familiar room which had served me for parlour, bedroom, and study, for laboratory, museum, and painting-room, with all the pleasant memories that had centred in it, was empty and bare. In front of the house, under the great teak tree, stood the two bullock-carts laden with my thirty chests of specimens, &c. Beyond the garden-gate were ranged row upon row of the brown villagers watching the departure of the stranger who had been so great an object of curiosity and amazement to them all these weeks. I took leave personally of the two chiefs and of all the more important inhabitants of the village. Good old Socrates, with sorrowful mien, produced for the last time the best of his bananas and mangoes, annonas and cashu-nuts. For the last time Babua climbed my favourite palm to offer me one more draught of sweet, cool cocoa milk. Hardest of all was the parting with my faithful Ganymede. The poor lad wept bitterly, and earnestly begged me to take him with me to Europe. It was in vain that I sought to persuade him, as I had often done before, that this was impossible, and that he could not live in our icy climate and beneath our grey skies. He clung fast round my knees, and assured me that he was ready to follow me anywhere without hesitation. I was obliged at last to disengage myself almost by force, and mount my vehicle. As I waved a last adieu to my dark-skinned friends, I had all the feeling of Paradise Lost—'Schoner Edelstein! Bella Gemma!'"

THE SANITARY INSTITUTE

ONE of the first objects which the Sanitary Institute of Great Britain has set itself to accomplish is the diffusion throughout the country of such information as shall lead to increased knowledge concerning the laws of health, and to an improvement in the conditions under which people live. Amongst the means by which it is sought to attain this object at each annual congress, is the delivery of public addresses in the several sections. This course was, as usual, followed at Newcastle-on-Tyne, and many of the addresses contained matter of much interest.

Dr. Embleton as a resident in the borough visited by the Institute, referred to such measures as had been adopted in Newcastle to secure greater cleanliness of air and water. He deplored the manner in which air was still contaminated by the products of the combustion of coal in the large manufacturing districts; he vividly described the conditions resulting from the constant inhalation of the solid and gaseous matter contained in smoke, and having reference to some of the principal local trades, he explained how hurtful from an economical point of view was the diffusion into the atmosphere of the valuable, unburnt, and therefore wasted carbon, the carbonic acid and oxide, the sulphurous acid, and the fumes of hydrochloric acid, of lead, copper, arsenic, and other vapours. Looking hopefully into the future, and anticipating that with the growth of knowledge in matters relating to health, there would also come a material increase in the duration of human life, he sought to give some estimate of the normal length of the life of man. Accepting the rule laid down by Buffon and Fleurens that the full term of normal life is dependent upon the age at which growth is completed, he pointed out that according to Dr. Quain, the epiphyses of the long bones of the extremity in man are not perfect as regards their ossification until the age of from 23 to 25 years. At that age natural growth is finally completed, and Fleurens, multiplying this age by 5, brought man's normal age to some 125 years. Dr. Farr has been less hopeful, and has regarded the natural term of human life as at about 100 years, whereas he has shown that the actual mean age at death under existing circumstances is slightly under 41 years. Man, according to Dr. Embleton, is himself greatly to blame for his short existence, and he urged his hearers not to go away contented, merely because health officers were now devoting all their time to the removal of conditions inimical to life, but rather themselves to attend to the sanitation of their bodies, their houses, and their surroundings.—Mr. Henry Armstrong, Medical Officer of Health for the City, gave a somewhat detailed history of Newcastle, from a health point of view. Having regard to the many difficult sanitary problems to be dealt with, he urged that it was necessary to remember the extreme antiquity of the borough, and in estimating what had been done, to compare the present with the more remote past. In the thirteenth and fourteenth centuries, epidemics, which lasted from one to three years, occurred in the borough. In the time of James I. so little regard was had to cleanliness, that the "dunghill" within the castle precincts "had increased to such a size and bigness, that it was in length 98 yards, the depth of it was 10 yards, and the breadth of it 32 yards," some 27,000 tons of filth having thus been allowed to accumulate. In the seventeenth century the Great Plague was one of eleven epidemics; it alone caused 7000 deaths, and it led, by the almost complete desertion of the town and port, to a ruined trade and wasted treasury. Even in 1853, at the date of the then prevailing cholera epidemic, it is reported that the town so abounded in narrow yards, lanes, and "entries," that in one district alone there were streets exceeding a mile in length, which had an average width of some four feet only. Since then, rapid progress has been made; good water, improved sewerage, and better dwellings have been provided, and although much remains to be done in an ancient city which is in certain parts so crowded as to prevent that proper movement of air about dwellings which is necessary to health, yet the reduction of the yearly death-rate per 1000 by ten in as many years, and the diminution in the same time of typhus to one-fifth of its prevalence in the period immediately before, are matters of congratulation, and tangible results of good work effected.—Prof. Henry Robinson, in dealing with the question of house sanitation, pointed out that not one quarter of the dwellings of all classes—high or low, rich or poor—are free from dangers to health, due to defects with respect of drainage, water, or ventilation, and he gave a summary of the rules which should everywhere be laid down to secure entire disconnection between the interior of houses and the public sewers, basing his remarks in this connection on the model series of bye-laws issued by the Local Government Board. Mr. Robinson's estimate of the proportion of unhealthy houses is, we fear, below the mark, and in towns it is probable that the houses of the well-to-do exhibit greater sources of danger than those of the poor, and this by reason of the number of pipes passing from cisterns, baths, sinks, lavatories, &c., directly into the drains. By means of these direct connections sewer air can, notwithstanding water-traps, easily make its way into dwellings, and the more numerous they are, the greater the danger. Dealing with the question of sewer-ventilation, Prof. Robinson urged the necessity for frequent ventilating-apertures in the course of the public sewers, and in considering the best method of effecting this, he objected to the construction of ventilating shafts in connection with dwellings, deeming it desirable that the ventilation of the main sewer should be accomplished independently of the ventilation of house drains. On the question of water-supply, Prof. Robinson pointed out, as we had already done in commenting on Capt. Galton's address, that chemical analysis could not be regarded as alone sufficing for the determination of the wholesomeness or otherwise of a water-service, especially in the case of rivers liable to contamination by animal organic matter, and he laid it down as a rule that the only way to insure perfect safety was to exclude all waters which were not altogether free from the possibility of pollution. The view held by Mr. W. G. Laws on sewer ventilation differed entirely from those of Prof. Robinson. He advocated the extension upwards of the soil-pipe of houses in such a way as to convey a current of sewer air through the house drain to a point above the roof, and hence he objected to the existence of a trap in the course of the house drain to the sewer. There is one fatal objection to this system, and that is, that if the slightest failure occurs in the plumber's or mason's work, the foul air from the sewer makes its way into the houses, a result which has often ensued, and this with fatal consequences. By the adoption of the principles laid down in the Model Byelaws, and which received Prof. Robinson's commendation, a current of fresh air instead of foul air would constantly pass through the house drains, and this is the result which architects should aim at securing. How far the "gas chimney" advocated by Mr. Laws would answer, it is difficult to say, but we would point out that as yet the Legislature has given no powers to enable authorities to make use of dwellings for the purposes of the ventilation of public sewers.—Mr. E. C. Robins, F.S.A., drew the attention of the Congress to the admirable work on the exclusion of sewer air from houses, which has recently been published by Dr. Renk, of Munich, and which deals with this important question in much detail, and in a thoroughly scientific spirit. One very important question is raised by Dr. Renk, namely, whether the mere inhalation of air from sewers is ever provocative of specific forms of disease. He is inclined to the opinion that the particular matter of infection cannot pass into the human system by means of the superincumbent air alone. Doubts as to this have been raised before, but the emanations from sewers are largely composed of aqueous vapour, which must be regarded as capable of holding infective matter in suspension, and Dr. Frankland, in his paper before the Royal Society, has shown that in the process of the breaking of minute bubbles on the surface of flowing sewage, liquid particles capable of conveying infective solid particles are largely transported into the surrounding air.—Mr. James Leman contributed a useful paper summarising the conditions under which it is desirable as far as possible to separate rainfall from sewage with a view to securing an efficient method of sewage disposal. The adoption of the so-called "separate system" has unquestionable advantages as regards towns which are so circumstanced that it becomes imperative to reduce, as far as possible, the amount of liquid to be dealt with at the outfall, but it can never be absolutely carried out, for it is nearly everywhere necessary to admit into the sewers such rain-water as that which falls on the surface of roads and which is liable to be contaminated, and also to make provision for the occasional flushing of sewers during storms.—Dr. Bartlett, F.C.S., communicated an interesting paper on the influence of suspended matter on health. He detailed at some length a series of failures to procure specimens on the one hand, of the infectious matter of the various contagia, and, on the other, of the particles which swarm in the air emanating from sewers and other sources, and which give rise to unwholesome conditions of air. He next described how resort was had to the peculiar and beautiful waste product of the smelting furnace, slag-wool, as a medium through which to filter air, and how by its means floating particles composed of living organic matter, consisting in part of cells or corpuscles of animal origin had been found in air which had been vitiated from certain sources, and how by means of the discovery the sources of evil were detected and hence done away with. Dr. Bartlett holds a strong opinion against the probability of finding specific disease germs in any form by which our present powers of observation can recognise them, but he is equally impressed with the indications afforded by the results of some of his experiments as to the noxious influence of animal organisms, including, perhaps, the specific matter of the various contagia and of tubercle, which are often contained in impure air.

Capt. R. T. Hildyard drew attention to the influence for good which might be exerted by medical men if, in the course of their private practice, they had more regard to the sanitary conditions under which their patients were living.—The Hon. J. A. R. Russell brought gether a large amount of carefully-prepared meteorological and other statistics to show how climate improved with slight elevation. In a series of conclusions to which his observations had led, he pointed out how the ranges of temperature, yearly, monthly, and diurnal, were less at certain elevations than in lower sites, and he regarded it most desirable that every house should be built on arches or on piers admitting of ventilation above the ground level, and that in country districts no house should be considered habitable of which the floor is on a level with or below the ground.—Miss Yates, Hon. Sec. to the Bread Reform League, pointed out the advantages of wheat-meal bread over white bread, both as regards its nutritive properties and otherwise, and urged its general use as a means of promoting national health, especially amongst the classes depending on bread as their main article of food.

ON THE PERCEPTION OF COLOURS BY THE ANCIENT MAORIS

IN an interesting paper on this subject by Mr. Colenso, he gives a great deal of information on this subject, derived from his individual experience during a very long period of dwelling among the Maoris, and that before the country was settled, and by his having travelled very much among them, frequently in parts where no white man had ever been, sometimes on the battle-field, both during and after the fight, ever with them as medical man, often in the confidence of their best head men. The colours of black, white, red and brown were the prized and favourite ones. The purer states, especially of each of these colours were highly valued, to which may be added green and yellow. These several colours and their varying hues comprised nearly all that pertained to their dresses and personal decorations, to their principal houses and canoes. In the olden times a chief's house might truly be called a house "of many colours," which were artistically and laboriously displayed. Each tint or shade of colour bore its own peculiar name plainly and naturally, or figuratively sometimes both. They possessed a fine general discrimination of the various shades and hues and tints; they could give an accurate description of a rainbow, of all its various colours; they noticed the iridescent hues of the feathers of a pigeon's neck, of some shells, and the delicate evanescent tints on the ventral surfaces of many fish. From their general hues alone the Maoris could accurately tell whether far off and to them unknown districts were covered with a vegetation of fern or flax (Phormium) or grasses, but far above all their fine discrimination of delicate hues and shades was correctly shown in their nice distinction of the various tints of the flesh of the several kinds of kumara and taro. Once travelling on the coast, nearly forty years ago, Colenso met an old chief who told him that long ago he had cultivated a variety of the taro, which is called Wairuaarangi, but that it had long been lost. Knowing this sort from having met it in the north, and remembering the delicate and curious pink colour, Colenso tested the knowledge of the chief by asking what colour it was, which he immediately minutely described. They had early succeeded in getting brilliant black and red dyes. The old Maoris had a peculiar bias towards neutral colours. Blue was certainly known to them, and they obtained it from two sources, one mineral, the other vegetable; and they had even distinct names for several shades of blue. Throughout this paper Mr. Colenso criticises and contradicts many of the assertions made by Mr. Stack, from probably an insufficient knowledge of Maori, in a memoir recently published on the colour-sense of the Maoris (*Trans.* New Zealand Institute, vol. xiv. p. 49).

FRIEDRICH WÖHLER

WÖHLER is dead. A man, who was born four years after Priestley died, who worked with Berzelius, who was engaged in chemical research when the brilliant genius of Davy was ranging over the whole field of chemical phenomena, who was contemporaneous with Liebig and Graham—this man has but now passed away from our midst.

Wöhler witnessed, and well bore his part in helping on the many great advances which chemistry has made since the science was founded by Black, Priestley, and Lavoisier.

Friedrich Wöhler was born in 1800 near Frankfurt; he graduated as Doctor of Medicine at Heidelberg in 1823, but in place of pursuing the study of the uncertain art of medicine, as he tells us in his "Reminiscences," he determined to devote himself to the more exact science of chemistry. Recommended to Berzelius by Gmelin, Wöhler spent the winter of 1823-4 in the laboratory of the great Swedish chemist.

As we read the Reminiscences of Wöhler's youth—published a few years ago in the *Berichte* of the Berlin Chemical Society—we are ready to exclaim that it was impossible that, with the appliances which he had at his command, Berzelius could accomplish chemical work of any value. A few tables, an oil lamp or two, a large jar of water, basins and flasks—that was nearly all. The ancient Anna cooked in the kitchen, where also stood the sand-bath and the rarely-used furnace; Anna still spoke in these days of "oxidised marine acid gas;" but Berzelius was beginning to think that it might be better to say chlorine.

Five years later we come to a date memorable in the history of chemistry. Hitherto it had seemed as if the boundary which chemists had found it convenient to draw between organic and inorganic chemistry had a real existence in nature; but Wöhler's preparation of urea, in 1828, from constituents of mineral origin, showed that this chemical boundary was as unreal as any other drawn by the too ardent devotees of system; and that, as Graham said, in nature "distinctions of class are never absolute." The artificial barrier broken down, the living science of the chemistry of carbon compounds rapidly grew and overspread the place where the dead wall had been. Wöhler's discovery seemed a small one at the time, but what great fruit has it borne:

> "Walls admit of no expansion,
> Trellis work may haply flower
> Twice the size."

About this time (1830) the reaction led by Dumas against the Berzelian system of classification was growing in strength; in their zeal to overthrow the evils which had arisen from the axiom of the Swedish chemist—that every compound must be built up of two electrically opposed parts—chemists had sought likewise to demolish the conception of compound radicles, which formed so marked a feature of the Berzelian system.

But the classical research of Liebig and Wöhler on "oil of bitter almonds" in 1832, recalled investigators to the true paths of advance. By recognising the existence in a series of compound molecules of a group of elementary atoms—which group they called *benzoyl*—Liebig and Wöhler were able to bring together, and so to explain the properties of compounds derived from this oil, compounds which to the less imaginative chemist appeared to belong to altogether different classes of bodies.

Thus was inaugurated the modern conception of compound radicle, a conception which, being much more elastic than that of the Berzelian radicle which preceded it, and being at the same time sufficiently precise, was destined to lead to that of a replacing value for each radicle, and so to be merged in the wider hypothesis of the chemical equivalency of elementary atoms.

But in other and different fields the influence of the work of Wöhler has also been felt. Called to the Professorship of Chemistry at Göttingen in 1836, for more than forty years Wöhler pursued his investigations into the properties of metals and metallic compounds. Do we not owe to him much of our knowledge of aluminium and of nickel? Was it not he who taught us how to separate cobalt from nickel and from manganese? Did we not learn from him much concerning the properties of chromium, tungsten, tellurium, arsenic, and titanium?

His researches have thrown light on the chemistry of palladium and iridium, of beryllium and yttrium, and largely on the properties of silicon.

In 1833 Wöhler published the "Grundriss der Chemie," a book which is known wherever chemistry is studied, and which has been translated into the English, French, Dutch, Swedish, and Danish languages.

In 1861 the publication of his "Mineral Analysis" enriched analytical chemistry with methods of rare accuracy and general applicability.

Wöhler's translations into German of the *Lehrbuch* and *Jahresberichte* of Berzelius brought those classical works within the reach of every chemist.

But what shall be said of the influence of this great student of nature on others? Many a chemist looks to Göttingen as to the place where he learned what research means.

He has lived long and nobly; he has seen chemistry grow from a feeble plant to a spreading tree, and to that growth he has in no small measure ministered.

M. M. P. M.

PALÆOLITHIC GRAVELS OF NORTH-EAST LONDON

DURING the present spring and summer several new and instructive sections through the beds containing Palæolithic implements have been laid open at and near Stoke Newington. For the first time in my memory sections have been exposed which show the real age of the beds near the valley of the Hackney Brook, together with the older deposits on which they rest. Stoke Newington, Highbury, and Hackney are now so much built over, and where not built over, the surface of the ground has been so much .disturbed for market gardening, brick-making, and excavations for sand and gravel, that one might live near the place for a lifetime and never see a section of four feet which would show the true nature of the uppermost deposits.

In NATURE, vol. xxv. p. 460, I described the "Palæolithic Floor" lighted on by me at Stoke Newington. This "floor" is a place where Palæolithic implements and flakes occur in large numbers. They are found about four feet beneath the surface of the ground, and nearly all the examples are as sharp as knives. That this was really a working place where tools were made in Palæolithic times is proved by the fact of my replacing flakes on to the blocks from which they were originally struck Hitherto I have described this "floor" as belonging to the Hackney Brook, and Dr. John Evans, in his "Stone Implements of Great Britain," p. 523, says: "The Shacklewell gravel lies on the slopes of the valley of the Hackney Brook." This in one sense, is really the case, but recent sections show that the Hackney Brook is quite modern, that it has cut its way through the Shacklewell gravels and only slightly disturbed them; in some places it has washed the "Palæolithic Floor" quite away. The "floor" really belongs to the Thames and the Lea, and one part of it occurs at the point of the former confluence of the two streams at four miles north of the Tower of London. It is also older than the "trail" or "warp" of the Rev. O. Fisher which occurs just above the "floor." The "floor" I now find to be by no means restricted to the slopes of the Hackney Brook, for I have seen a good section of it with tools and flakes *in situ* at three-quarters of a mile to the east of the stream and quite removed from its slopes. The present Hackney Brook may possibly follow some old depression left by previous denudation on the north bank and bed of the ancient Thames, but that is all. I have no doubt that the unabraded implement found at the bottom of a sand and gravel pit at Highbury by Mr. Norman Evans ("Stone Implements," p. 525) and compared by Dr. John Evans to the tools from Hoxne, High Lodge, and the cave of Le Moustier, really belongs to the "Palæolithic Floor," for I have an example recently found by myself near the Highbury position, which I know came from the "floor," for I there saw the "floor" in section. The unabraded implements, from their character and position clearly belong to a recent Palæolithic period, and they agree partly with the Le Moustier examples, but the Hackney Brook is far more modern than the most recent of Palæolithic times. At first the evidence seemed to indicate that the men worked on the old banks of the brook; it is now clear, however, that it was on the immensely older banks of the ancient Thames, that the men really fabricated their tools.

As no section through the "Palæolithic Floor" has hitherto been published, the accompanying illustration, Fig. 1, engraved to scale, will give an idea of its nature. The upper part of the illustration shows a section, facing the east, 300 feet long from north to south. It is taken through the gardens between Alkham and Kyverdale Road and south of Cazenove Road—the latter is shown on Stanford's Library Map of London. It is north of, and close to Stoke Newington Common. The south end, nearest the brook, is 83 feet 3 inches above the ordnance datum, whilst the north end is 90 feet 6 inches, showing a rise of 7 feet 3 inches in 300 feet—the heights are my own. Varying at from 4 feet to 6 feet from the surface there is a thin stratum of sub-angular broken flints and other stones seldom more than 4 or 5 inches in thickness, and sometimes obliterated or with only a single thickness of stones. This is the "Palæolithic Floor," and it is indicated in the upper part of Fig. 1 by the letters A, A, A. At 8 feet below the "floor" and about 12 feet from the surface of the ground is a bed of gravel and sand about 8 feet in thickness containing implements of older date; this bed is shown at the base of both the upper and lower sections seen in Fig. 1.

To more clearly show the nature of the "floor," the 60 feet of the upper figure (where marked) is engraved below to a larger scale; B is the 12 feet gravel containing rolled fossil bones and abraded Palæolithic implements; C is fine buff-coloured sand, often full of fossil shells of land and freshwater molluscs, D D D is the "floor," with its numerous unabraded tools and flakes; in the part illustrated, the "floor" is in duplicate. After the men had made their tools on the "floor" where the lower D's occur, a slight flood of water covered up the tools with a thin coating of sand; the men then walked over the newly-deposited material, and made other tools on the new "floor." The two white streaks on the top of the upper "floor" are London Clay mixed with sand. Sometimes the tools and flakes are to be seen in this clay, but of course they were washed into it in Palæolithic times by floods. Above the "floor" is sandy loam and loamy sand; the uppermost part, and sometimes the whole of the material above the "floor," is not water-laid; in other words, it is one form of "trail;" above this "trail," where the darker tint is engraved, is humus, with Neolithic celts and flakes.

When the material above the "floor" is carefully removed, as I have so had it removed for me several times, the surface of the old working place is exposed. The stones are chiefly subangular broken flints, under the average size, the crust sometimes ochreous, at other times grey, quartzite pebbles, pieces of sandstone, a few pieces of quartz, cretaceous fossils, and numerous small grey flint pebbles, with traces of chalk. Intermixed with these stones are large numbers of keen lustrous flakes and many implements, all sharp, and as a rule (not without exceptions) small in size and well made, some so exquisitely made as to rival the best Neolithic work. With these tools, fossil bones, mostly broken, belonging to the mammoth, horse, bison, and reindeer, occur with broken tusks, teeth, and antlers of the same and other animals; human bones and teeth I have never been able to light on. I have, however, many times seen such tender things as leaves, small pieces of wood and small crushed branches, generally, especially is this the case with the leaves, very friable. Molluscan remains in immediate contact with the "floor" sometimes occur, and I have seen them both below and above it, and in contact with the bones and implements. Three or four feet below the "floor," shells are sometimes very common. Both under and above the "floor" are occasional seams and blocks of London clay, brought from a short distance to the north-west, where the clay comes to the surface. As a rule there are no very large blocks of flint or other large stones on the "floor." The non-waterlaid covering mass often disturbs the "floor," ploughs it up, and pushes underneath it. The twisting, contortion, and undulation of the material above the "floor" seems to prove that it was laid down by moving ice from the north. This ice-deposited "trail" is full of small whitish pebbles; fixed in the tenacious material at various angles. Abraded and whitened

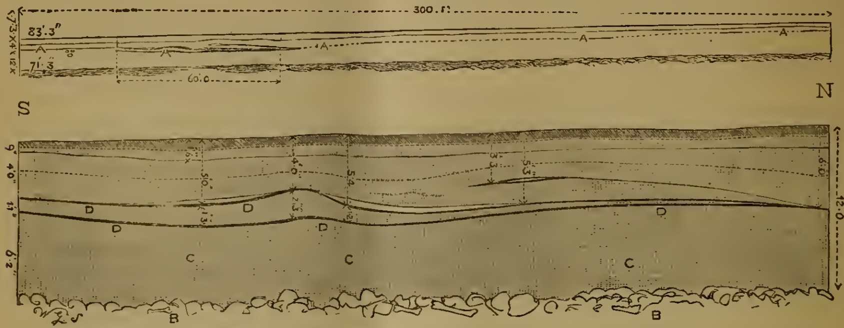


FIG. 1.

implements are also met with in the "trail," examples no doubt caught up from old exposed surfaces by the ice-sheet, and brought from a distance to their present position. No Palæolithic implements occur above the "trail," the "trail" seals up all the relics of the Palæolithic age, and as far as the evidence of north-east London goes, Palæolithic man had quite retired before the "trail" was deposited. When implements are found on the surface, the ground may have been denuded, and the implements exposed.

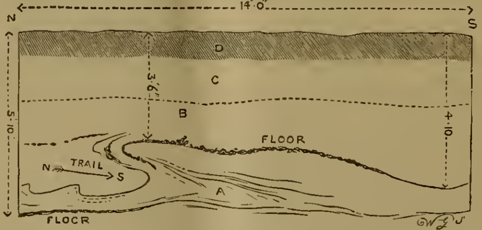


FIG. 2.

Fig. 2 is a measured section through the "floor" facing west; on the other side of the section, illustrated in Fig. 1, the "floor" is seen at from 3 feet 6 inches to 4 feet 10 inches beneath the surface, muddy trail, with sand and a few stones, is present at B and C, — D is humus. In the direction of the arrow, from north to south, the "trail" is seen pushing under and upheaving the "floor" with its implements; the Hackney Brook is towards the south, and a flooded brook to the south would hardly upheave the "floor" from the north; A is a mass of London clay and sand brought from a distance and pushed under the "floor" by the advancing "trail" from the north. Where the "floor" has been crumpled and disturbed, the implements show a very small amount of abrasion, when the "floor" is covered by the stratified sand or mud of the river, the tools are all as sharp as on the day they were made.

It fortunately happens that very near the sections here illustrated, viz. at 270 yards west by north from Clapton Railway Station, and just south of Caroline Street (marked on Stanford's map), one or two other cuttings have quite recently been made, these show admirable sections of characteristic "trail." At Fig. 3 a section facing south is engraved to scale, and at Fig. 4 the end of the section is further enlarged to show the "trail" above and the stratification below. The section is 11 feet 6 inches deep, and just reaches the top of the stratum of gravel which contains implements intermediate in age between those of the "floor" above, and those found from 20 feet to 30 feet beneath the surface. The "Palæolithic Floor" on Fig. 4, if present, would be just above the hortozanal bands of stratification, but the "trail" at this spot has swept it away, it however occurs in a perfect state a few yards off. Beginning at the top, the reference-letter. R, is humus; Q, mud belonging to the "trail"; O, "trail"; P, a pocket of London Clay; N, Palæolithic sand and loam crumpled and disturbed by the "trail"; M, dark sand and clays; L, light sand and clay; K, dark sand and clay; J, yellow sand; I, red sand; H, light sand and clay; G, dark sand and clay; F, red sand; E, yellow sand; D, red sand; C, sand, almost white; B, buff sand, sometimes full of the fossil shells of land and freshwater molluscs. These sands represent the sandy margin of the old Thames, now four miles distant from this spot.

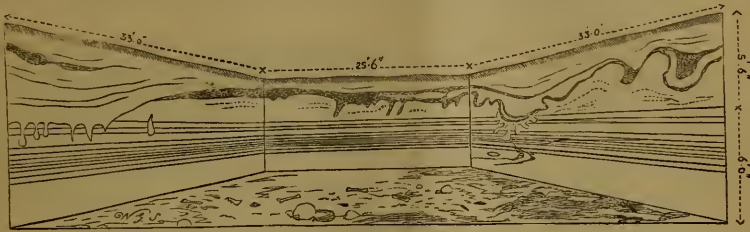


FIG. 3.

Some of the shells found in it by me have been kindly named by Dr. J. Gwyn Jeffreys; the series is probably very imperfect, as the time I have for geological matters is extremely limited, but no doubt the list is typical, as I have many times met with the species hereafter mentioned; other species may be more rare or local.

1. *Corbicula fluminalis*, Müll., extremely common.
2. *Hydrobia marginata*, Mich., not uncommon.
3. *Sphærium corneum*, Linn.
4. *Pisidium fontinale*, Drap.; var. *Henslowana*, Jen.

FIG. 4.

5. *P. amnicum*, Müll.
6. *Unio tumidus*, Phil.
7. *Bythinia tentaculata*, Linn, extremely common, with abundant free opercula.
8. *Valvata piscinalis*, Müll., var. *subcylindrica*.
9. *Planorbis albus*, Müll.
10. *P. complanatus*, Linn.
11. *Limnæa auricularia*, Linn.
12. *L. truncatula*, Müll.
13. *L. peregra*, Müll.
14. *Ancylus fluviatilis*, Müll.
15. *Helix concinna*, Jeffr.
16. *H. nemoralis*, Linn.

Dr. Jeffreys was good enough to add the following note:—"The occurrence of *Pisidium fontinale*, var. *Henslowana*, as well as the *tout ensemble* of all these fossil shells, induces me to believe that they had been thrown up by floods on the banks of a large river such as the Thames." A mile to the west at Highbury, other molluscan genera are represented. A list of the Highbury shells is given by Dr. John Evans—"Stone Implements," p. 524.

I now come to the bed of gravel indicated at B (Fig. 1) and A (Fig. 4). It is found at an average depth of 12 feet, and descends to 20 or 30 feet from the surface; this drift contains, chiefly in its upper parts, lustrous sub-abraded Palæolithic implements of medium age. All these tools have been more or less moved and relaid by the agency of water; none are quite unabraded; bones, teeth, and tusks of the mammoth also occur, with other mammalian remains, driftwood, &c. This deposit has been described by Prof. Prestwich in the *Quarterly Journal of the Geological Society*, 1855, vol. xi. p. 107. The material is remarkable for containing immense blocks of sandstone, probably never moved by water alone, and sometimes weighing one, two, or more hundredweights; that these stones fell from blocks of drifting ice seems extremely probable. Some of them measure two feet across, and they must have been brought from the north long prior to the deposition of the trail, and probably long after the time when other immense blocks found at 20 feet and 30 feet at the bottom of the gravel were deposited. Some show glacial striæ. Generally in the deepest pits, the third and oldest class of implements is found, the examples are rudely made, massive, deeply ochreous in colour, with a thick ochreous crust, the ochreous tint not derived from the matrix they are now in; they are generally very much abraded, indicating transport from a long distance, or long dashing about in water with other stones, but as the three different classes of implements will be illustrated in my concluding note, and proved to be of totally distinct ages, far removed from each other, I need not refer to them at length here.

It commonly happens, that the higher the gravels above the present rivers, the older they are, but here we have an instance where the newer gravels and more recent implements are from 8 feet to 26 feet higher than the old.

WORTHINGTON G. SMITH

THE COMET

THE Astronomer-Royal has received, through Sir James Anderson, a telegram from Mr. Gill, in the following terms:—"Please inform Astronomer-Royal that comet's declination in my letter of September 11 should be 56 minutes 30 seconds south. Sudden disappearance of comet at ingress on sun's disc observed September 17 days 4 hours 50 minutes 58 seconds Cape mean time. Comet not visible on sun." Mr. Gill's remarkable observation is without a precedent, and an extraordinary illustration of the intense brilliancy which the comet attained at perihelion.

The Emperor of Brazil telegraphs thus to the Academy of Sciences of Paris:—"Rio, 26 Septembre, 10h. 20m. Note Cruls. Grande comète australe visible de jour observée aujourd'hui. Queue 30°. Présence sodium et carbone. 25 Septembre.—Visible de jour au sud de Rio 18, 19, 20. Vue par moi aujourd'hui de 4h. 10m. à 5h. 40m. matin. Splendide 26."

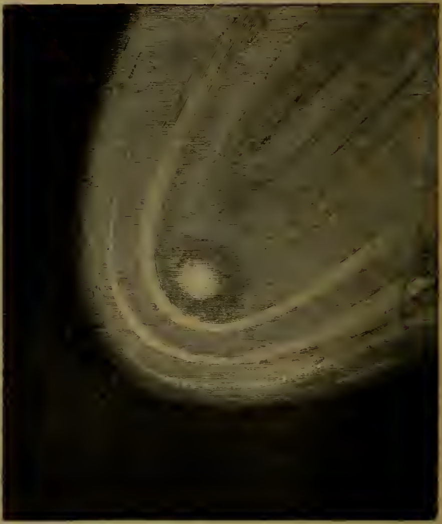
Mr. Ainslie Common, of Ealing, whose daylight observations on September 17 may have an important bearing on the theory of the comet, has furnished us with the following extract from his note-book on that date:—

		Value.
"10.45.	Found bright comet. S.W. sun.	
10.59.	Comet precedes sun, 6m. 50s., centre to centre	3
11.10.	Comet south, sun's limb, 20R 50D = 18′ 8″...	
11.47.	Comet precedes sun, 5m. 48s. (?)	1
11.58.	Comet south, sun's limb, 16R 60D = 14′ 41″...	
12.0.	Comet precedes sun, 5m. 44s. (good)	3
12.6.	Comet south, sun's limb, 15R 55D = 13′ 45″...	

Clouds came over shortly after this."

Mr. Common has corrected an error in reducing the last micrometrical difference of declination into arc: one revolution = 53″·1. He states that he made an immediate attempt to telegraph to Greenwich and Dun Echt, but the office at Ealing was unfortunately closed.

We have received several drawings from M. Bulard, of Algiers, showing the appearance of the comet as viewed with the naked eye, in one of which the tail is depicted with considerable curvature. Also a sketch of the head as seen in a powerful telescope, exhibiting the system of envelopes rising from the nucleus, which has characterised several recent bright comets (see Figure).



The following elements of this comet have been calculated by Mr. Hind from the Dun Echt and Coimbra meridian observations on September 18, a meridian observation at the U.S. Naval Observatory, Washington, on September 21, and an observation made at the Collegio Romano, at Rome, on the morning of October 2, obligingly communicated by Prof. Millosevich:—

Perihelion passage, September 17·2169, Greenwich M.T.

	°	′	″	
Longitude of perihelion	276	14	36	Apparent equinox Sept. 25.
,, ascending node	346	6	58	
Inclination	37	58	59	
Logarithm of perihelion distance ...	7·906527			

Motion—retrograde.

These elements afford further indication of disturbance of the comet's motion near the time of passage through perihelion. At the moment when Mr. Gill observed the comet upon the sun's limb, when the distance from the sun's centre was consequently 16′·0, the orbit gives the central distance, as 10′·9, or the comet projected upon the sun's disc. Considering that Mr. Gill's observation was made less than one day previous to the accordant meridian observations at Dun Echt and Coimbra, it is not easy to see how such difference could arise from error of elements, which represent the middle position employed in their determination within a minute of arc.

The following expressions for the comet's heliocentric co-ordinates x, y, z, referred to the equator, are to be used in connection with the X, Y, Z of the *Nautical Almanac*, in the calculation of geocentric positions:—

$$x = r.[9{\cdot}99521].\sin(v + 9^{\circ}\ 6'{\cdot}2)$$
$$y = r.[9{\cdot}98774].\sin(v + 277\ \ 2{\cdot}4)$$
$$z = r.[9{\cdot}44252].\sin(v + 130\ \ 17{\cdot}5)$$

r being the radius-vector, and *v* the true anomaly.

[Mr. Gill writes on September 19: "Yesterday and to-day the comet is a brilliant daylight object, and was observed on the meridian by myself with the Transit Circle. We have a whole lot of Alt-Azimuth observations which will be reduced as soon as possible. They were the only kind of observations possible, as the comet was only visible by glimpses through holes in the cloud between September 8 and perihelion."

In a letter addressed on the same day to the Astronomer Royal (with a copy of which he has favoured us) Mr. Gill says: "On Sunday, the 17th inst., the comet was followed by two observers with separate instruments right up to the sun's limb, where it suddenly disappeared at 4h. 50m. 58s. Cape M.T."]

NOTES

PROBABLY some of our readers may have heard that Mr. W. Spottiswoode met with an accident recently. The fact is that on September 30 last he broke his left humerus within the capsule, through the overturning of the tricycle he was riding. He has, we are glad to learn, been carefully attended, and is getting on as well as possible.

A PRIVATE letter to this country conveys the intelligence of the death, on September 11, at Kandy, of Dr. Thwaites, F.R.S., for many years director of the Royal Botanic Gardens, Peadeniya, Ceylon. We shall defer to a future issue some particulars of his life.

THE death is announced, at the early age of forty-eight years, of the well-known scientific photographer, Dr. D. Van Monckhoven.

WE are glad to learn that a memorial signed by Professors Paget, Humphry, Hughes, Newton, and Moseley, Drs. Michael Foster and S. H. Vines, and Messrs. G. H. Darwin, E. W. Blore, Coutts Trotter, A. Sedgwick, and J. W. Clark, was presented to the Vice-Chancellor of Cambridge University (Dr. Porter) on the 4th inst., representing the desirability of establishing some memorial of the late Prof. Balfour in the University. The Vice-Chancellor, in accordance with this request, has called a meeting of Members of the Senate and others for October 21, at 4.30 p.m., in the Lecture-Room of Comparative Anatomy, in the New Museums, "to take steps to establish in the University a memorial of the late Prof. Balfour."

SOME forty eminent German botanists met at Eisenach on September 16, under the presidency of Professors Pringsheim, Cramer, and Willkomm, and founded a German Botanical Society. The new society has its seat at Berlin, and its object is to form an effective and supporting centre for all efforts in the domain of scientific botany in Germany.

As is well known, the French Institute is divided into five classes, which meet together once every year. The president of this reunion is chosen in rotation from among the president of each of the five sections. The chair will be occupied this year by the president of the Academy of Sciences, who is styled director, and who happens to be M. Dumas, one of the two perpetual secretaries of the Academy of Sciences. M. Dumas will deliver on this occasion an address which it is stated will be of special importance. This meeting will take place on October 25 next.

M. DUMAS delivered at the sitting of the Academy of Sciences of October 9 an address summarising the works of the International Commission of Weights and Measures. He stated that the commissioners had executed a comparison between the original meter and kilogramme deposited in the Archives, with the new standards. The difference had been proved to be 0·000006m. for the meter, and 0·00001 gram for the kilogramme. The consequence is that a slight correction will be required for the measures taken with the international meter as the comparison between two measures of length can be executed with a precision of one part in ten millions. The new international kilogramme can be used without any correction at all.

TWO International Conferences will open in Paris on Monday next. One of these is for the object of settling upon a plan for the protection of sub-marine telegraph cables; the other is to establish throughout Europe the important desideratum of technical uniformity in relation to electricity. England, France, Germany, Austria, the United States, Spain, Denmark, Norway, and Sweden will be represented.

M. GABRIEL DE MORTILLET, Professor of Archæology to the School of Anthropology of Paris, has just published through Reinwald a work under the title of "Le Præhistorique," which may be considered as the first complete manual for the study of the Archæological Museum of St. Germain. M. Gabriel de Mortillet has been attached to this establishment from its foundation by Napoleon III. up to the present time, and is industriously engaged in its completion. The author, who is one of the few living geologists who investigated the formation of glaciers in Switzerland with Agassiz, attempts at the end of his volume to determine how far distant is the epoch when *Homo Sapiens* made his first appearance on the earth, by estimating the rate of progression of blocks which were carried by former ice-fields, and he comes to the conclusion that the space of time that has elapsed since that event took place exceeds 200,000 years.

THE meteorological station on the summit of the Säntis has recently been opened, and this latest Swiss station promises to be of importance with regard to the progress of meteorological science. In its altitude of 2504 metres it is surpassed only by the observatories on the Stelvio (2548 metres), the Pic du Midi in the Pyrenees (2877 metres), and the station upon the Colorado Peak (4340 metres).

THE *Panama Star and Herald* of September 14 gives details of several earthquake shocks which had visited the isthmus during the preceding week, doing much damage, but, fortunately, only causing two deaths. At 3.20 a.m. on Thursday, the 7th, the inhabitants were aroused from their beds by one of the longest and most severe earthquake shocks ever experienced in the city. It was preceded by a hollow, rumbling noise. The motion was wave-like, and proceeded almost directly from north to south. The first and most severe shock must have lasted at least 30 seconds. Extreme damage was done to buildings. A second and milder shock occurred about half an hour after the first. The Pacific Mail steamship *Clyde*, arriving from San Francisco, reported that the earthquake was severely felt on board. Passengers declared that it appeared as if the vessel were lifted bodily from the sea and allowed to fall back. The effects of the earthquake along the railroad were most marked. The stone abutments of several of the bridges were cracked and almost split, and the earthworks sank in half a dozen places. In several places where the direct action of the shock appears to have made itself most strongly felt, the rails were curved as if they had been intentionally bent. The severe shock on the morning of the 7th was followed during the day by several others of less intensity, and at 11.30 p.m. a sharp shock alarmed the whole city, and drove the people from their houses to the squares. Another slighter shock occurred at about three in the morning; but, fortunately, neither it nor its predecessor added further ruin to that already incurred in the city. All the shocks were felt on the islands in the bay, and some houses suffered at Taboga. On the morning of the 7th, at about 3.15, the residents of Colon were aroused by the earthquake shock which has caused so much alarm and damage to the whole isthmus. The duration of the shock was fully 60 seconds, and was so severe that the whole populace rushed into the streets as rapidly as their feet could carry them. About half an hour afterwards another shock was felt, but much lighter than the first. A deep fissure was opened in the earth from the south end of the freight-house for a distance of about 400 feet along the walk leading in the direction of the ice-houses. Many buildings were moved slightly from their foundations, but on the whole remarkably little damage was done. On board the vessels in the harbour the shock was also felt very severely. About 1 p.m. another much slighter shock was felt, and during the succeeding night two more slight disturbances were reported. It may be of meteorological interest to observe that the sea at the time remained calm, the atmosphere quite clear, and the stars and waning moon remarkably brilliant. Soon after, say about 4 o'clock, a slight fog wafted from inland; no rain fell. All day an ominous calm prevailed without rain, with fluctuating barometer and excessive heat. Another slight shock occurred at Panama on the morning of the 9th, a little before 5 o'clock, but fortunately no damage was done. The same shock was lightly felt in Colon and along the railroad track. All day on Saturday no shock was felt, and the night passed quietly. At mid-day on Saturday, there was a marked change in the atmosphere, and, with a refreshing shower which fell, the murky, sultry air of the previous days entirely disappeared. The rumours of a volcanic eruption at Chagres are entirely without foundation. The earthquake was felt there, did some little damage, and opened a few cracks in the ground. The earthquake of the 7th was felt at the Pearl Islands, in the bay. At Donoso, Govea, and Rio Indio a number of shocks were felt, and the people were much frightened. At Miguel la Borda, 35 miles from Colon, in the direction of Bocas del Toro, the tide rose to an unusual height and flooded some of the houses, which are built on the beach almost on a level with the sea. The earth sank in about a dozen places. The Governor of the district writes officially that several boiling springs suddenly appeared, some of which throw hot water to a considerable height. Letters have been received from the towns of La Villa, Chitré, Macaracas, ann Natà, all in the State, announcing that several shocks have been felt, but that the material of which the houses are built—bamboos and adobes—resisted the movements, and they suffered no damage. Two or three slight tremblings were experienced in Panama during the night of the 12th, but they caused no alarm, and many people were returning to their houses.

IN the Photographic Exhibition, which was opened in Pall Mall on Monday, there are several pictures of more than artistic interest. We may mention especially Captain Abney's views taken on the Alps, and showing the great difference in the photographic quality of the light reflected from the sky at high altitudes (9,000 to 10,000 feet), and that reflected at lower levels. Mr. Grant's photographs taken on board Mr. Leigh Smith's yacht *Eira* during her cruise to Franz Josef Land in 1880, are also of interest, as is also Mr. Shadbolt's photograph taken from the car of a balloon at the height of 2,000 feet, showing the streets and houses below.

THE Council of the Statistical Society have again decided to grant the sum of 20*l.* to the writer who may gain the "Howard Medal" in 1883. The subject is—"The best exposition of the experiences and opinions of John Howard on the preservation and improvement of the health of the inmates of schools, prisons, workhouses, hospitals, and other public institutions, as far as health is affected by structural arrangements relating to supplies of air and water, drainage, &c." Candidates are referred to the text and foot-notes of Howard's two works on "Prisons" and "Lazarettos."

BOTANISTS will learn with satisfaction that the Cavaliere d'Amico has succeeded, not without considerable difficulty, in acclimatising a number of foreign plants in Sicily. They are being exhibited at the present moment at the Agricultural Exhibition of Messina, and excite a great deal of interest among the spectators. Amongst them are the tea plant, *Persea gratissima*, *Cinchona succirubra*, *Indigofera tinctoria*, and *Myrica cerifera*. Cav. d'Amico intends to establish a tea plantation of some extent not far from Messina, and it is hoped that Sicilian tea may in a few years become an important article of commerce.

IN a vineyard at Bonn, Phylloxera have recently made their appearance. The necessary precautions were at once taken.

THE eminent Berlin sculptor, Herr Pohle, is now about to complete a bust of the celebrated geographer, Karl Ritter, for the Geographical Society of Berlin.

PROF. SIMON NEWCOMB, of Washington; Lieut. T. L. Casy, United States Army; Ensign J. H. L. Holcombe, United States Navy; and Mr. Julius Ulke, forming the expedition despatched by the Government of the United States to observe the transit of Venus at the Cape, left Plymouth last Friday in the Union Steamship Company's mail steamer *Durban*. Miss Newcomb, daughter of the Professor, the lady member of the expedition, is in London, the epidemic of smallpox at the Cape deterring her from proceeding with her father. Mr. Gill, the Astronomer Royal at the Cape, has expressed his willingness to render the members of the expedition every facility as to the selection of a station by collecting information. It is probable that Beaufort, which is 300 miles from Cape Town, will be chosen, from the fact that in that district there is proverbially a clear sky.

THE Danish astronomers, who have been selected to take observations of the transit of Venus, have left Copenhagen for Santa Cruz.

ON commencing his Winter course of lectures on Comparative Anatomy at King's College, Prof. Jeffery Bell made the following remarks:—"In ordinary circumstances it is well to proceed at once to the work before us, but, during the six months that have elapsed, since I last addressed a class of comparative anatomy from this chair, two heavy blows have fallen on the students of zoological science; the two most remarkable of English workers have been taken away from us, the one full of years and honours, the other the bearer of a glorious promise. I should not be doing my duty if I were not to ask you to pause for a moment on the threshold of your studies to bear witness with me to the regrets which we justly feel at the death of Charles Darwin, and the sense of irreparable loss which is connected with the name of F. M. Balfour. The father of modern zoology, the reformer of all our conceptions as to the workings of nature in the organic world, the assiduous and patient collector of the facts of natural history, the prince of observers and the leader of philosophical naturalists was carried to his grave in our national burying place amid the mourning of tthe whole civilised world; the broad outline of his work is well known to you all. On the treacherous slopes of an ice-bound mountain, away from kindred and friends, save such as his character had won for himself in an Alpine village, and yet always in the minds of those who knew him, Francis Balfour in, as we may be assured a moment of time, yielded up a life of which only thirty years had been spent, and lost to science and society what had promised to be as many years and more of patient and far-seeing investigation, free from prejudice, animated by the most scientific and philosophical of ideas while he himself, urged on by the success of the past, would have sought only fresh fields of victory in the future. It would be useless to point out in detail here, where so many are only beginners, the special services of Prof. Balfour, but you will note that his name will be constantly quoted during this course, as the discoverer of facts which have often thrown unexpected light on the problems of our science, and have always, at least, been of the highest importance, and stated with admirable truth and modesty."

THE *Annales de Chimie et de Physique* reproduces in its August number a paper relating to the theory of dissipation of energy, read by Macquorn Rankine at the British Association meeting in 1852.

A SERIES of scientific ascents were made on Sunday afternoon from the Place Saint Jacques, in Paris, under the auspices of the Académie d'Aérostation Météorologique. At a height of eight hundred feet photographs of the entire horizon were taken by means of a panoramic apparatus invented by M. Triboulet. In a brief explanation of this, given by one of the members of the Academy, it was pointed out that the experiment was as important from a military as from a scientific point of view, since it would enable an army to ascertain exactly the number and position of their enemies. At another ascent telephonic conversation with persons on the ground was carried on at the height of five hundred feet. The experiments were under the auspices of the Municipal Council of Paris.

THE aurora borealis which was seen in so many parts of England on October 2, was also visible in France from a very large number of places.

M. DUVAUX, the French Minister of Public Instruction, has opened the first superior school for females established in France. It is situated in the city of Rouen, and the regular course of study will begin this year. Many similar establishments are in course of construction in several parts of the country.

THE additions to the Zoological Society's Gardens during the past week include a Sykes's Monkey (*Cercopithecus albigularis* ♀) from East Africa, presented by Capt. F. W. Schwedler; a Binturong (*Arctictis binturong*) from Malacca; a Common Fox (*Canis vulpes* ♀), British, presented by Mrs. Studholme Brownrigg; two Goshawks (*Astur palumbarius*) from Germany, presented by Dr. Rudolph Blasius, C.M.Z.S.; a Common Raven (*Corvus corax*), two Lesser Black-backed Gulls (*Larus fuscus*) from Scotland, presented by Mr. F. G. Bury; two Greater Sulphur-crested Cockatoos (*Cacatua galerita*) from Australia, presented by Mr. C. Kerry Nicholls, F.Z.S.; a Puff Adder (*Vipera arietans*) from South Africa, presented by Lieut. R. Crawshay; an Ornamented Lorikeet (*Trichoglossus ornatus*) from Moluccas, a Crested Curassow (*Crax alector*) from Guiana, two Illiger's Macaws (*Ara maracana*) from Brazil, purchased; two Brazilian Hangnests (*Icterus jamaicai*) from Brazil, deposited; an Australian Fruit Bat (*Pteropus poliocephalus*), born in the Gardens.

CHEMICAL NOTES

AN exceedingly ingenious patent for the manufacture of hydrogen and oxygen has been taken out by M. N. A. Hélouis, of Paris. Wood charcoal is obtained by heating wood in closed vessels: the gas which is evolved is used for heating the retorts in which hydrogen and oxygen are produced, the tar is used for carburetting hydrogen, the pyroligneous acid is employed to decompose sodium sulphite (produced in another stage of the process), whereby sulphurous acid and sodium acetate are obtained. By passing steam over hot wood charcoal, a mixture of hydrogen, carbon monoxide, and dioxide is obtained; the mixed gases are passed into retorts containing heated gypsum, which is reduced by carbon monoxide to calcium sulphide; the escaping carbon monoxide is absorbed by soda solution, giving sodium bicarbonate. Oxygen is obtained by decomposing gypsum (600 parts) by silica (340 parts river sand); the mixture ot sulphur dioxide and oxygen which is produced, is passed into caustic soda solution, whereby sodium bisulphite is formed; the residual sulphur dioxide is absorbed by milk of lime. The calcium sulphite produced by the final washing of the mixed gases is decomposed by sodium bicarbonate, giving calcium carbonate and sodium bisulphite; the latter is decomposed, as already described, by pyroligneous acid, and the sulphurous acid produced is oxidised to sulphuric acid in a cylinder containing platinised pumice-stone, by air containing 75 per cent. of oxygen. The calcium sulphide which remains in the oxygen retorts is decomposed by carbon dioxide and steam; the sulphuretted hydrogen produced, after being freed from moisture by passing through a condensing apparatus, is burned with air rich in oxygen, and the sulphurous acid formed is conducted into the leaden chambers of the sulphuric acid manufactory. Air containing 75 per cent. oxygen is obtained by pumping air into a cylinder containing a mixture of 80 parts water and 20 parts glycerine; when the pressure has reached 10 atmospheres, communication is made between the first cylinder and another from which air has been removed; air rich in nitrogen remains in the first cylinder. By repeating this operation, a mixture of 75 per cent. oxygen and 25 per cent. nitrogen can be obtained. Another method of obtaining nearly pure oxygen from air consists in passing the latter into an iron cylinder containing a bag of silk covered with caoutchouc; the dialysed air is then driven by a steam jet into a condenser, and thence passes into a second similar cylinder; this process is repeated several times; a mixture of 98 per cent. oxygen and 3 per cent. nitrogen may thus be obtained, but for most metallurgical or lighting purposes a mixture containing 60 per cent. oxygen is sufficient. Nitrogen escapes from each iron cylinder by a side tube which dips under water. The silk bags used for dialysing air are prepared by washing ordinary caoutchouc with a mixture of carbon disulphide and alcohol (whereby substances are removed which would readily stop the pores of the caoutchouc-covered silk) making into a paste with benzene, and placing a layer of this between two layers of silk.

IN the *Scientific Proceedings* of the Ohio Mechanics' Institute (1. 35) a process is described for melting iridium by heating in a Hessian crucible with phosphorus, and subsequent renewal of the phosphorus by repeated fusion with lime. The metal, in very thin sheets, can be cut by a copper wheel making 2000 revolutions per minute, and having its surface covered with emery, or corundum, and oil. Metallic iridium is nearly as hard as ruby; no steel tools make any impression on it; attempts have been made, with fair success, to use it in place of carbon as the negative pole in the electric arc light.

IT is stated in the *Chemical Review* that recent analyses of the water from the *Holy Well* at Mecca, which is so eagerly drunk by pilgrims, show this water to be sewage, about ten times stronger than average London sewage.

ARTIFICIAL ivory of a pure white colour, and very durable has recently been manufactured by the inventor of celluloid: it is prepared by dissolving shellac in ammonia, mixing the solution with oxide of zinc, driving off ammonia by heating, powdering, and strongly compressing in moulds.

ON THE ALTERATIONS IN THE DIMENSIONS OF THE MAGNETIC METALS BY THE ACT OF MAGNETISATION[1]

DR. JOULE long since discovered that when a bar of iron was magnetised by an electric current, an *elongation* of the bar took place. In subsequent experiments, published in 1847, Joule found that the elongation amounted to about 1-200,000th of the length of the bar for the maximum magnetisation, and that the total elongation was nearly proportional to the square of the actual magnetisation. By placing the bar in a vessel of water stopped with a capillary tube, it was found that the volume of the iron did not augment, and hence Joule concluded that the sectional area diminished in proportion to the elongation. Under longitudinal tension, magnetisation caused a *shortening* of the rod when the tension exceeded 600 lbs. for a rod a quarter of an inch square. Soft steel behaved like iron; but hard steel, under all circumstances, Joule found to shorten slightly when the magnetising current passed

In 1873 Prof. Mayer repeated Joule's experiments with new and delicate apparatus; the elongation of the iron he found to amount to 1-277,000th of its length for the maximum magnetisation. Mayer also found that soft as well as hard steel contracted under magnetisation.

---

[1] Paper read at the Southampton Meeting of the British Association by Prof. W. F. Barrett, F.R.S.E., Professor of Physics in the Royal College of Science, Dublin.

In the same year I made a series of experiments on the other magnetic metal, nickel and cobalt, and found that whilst cobalt lengthened under magnetisation, nickel appeared to suffer no change.[1] This result is surprising, for nickel more nearly resembles iron and cobalt than steel in magnetic properties, the former having little coercive force, and the latter very considerable retentive power. With entirely new apparatus the experiments were repeated, and a distinct *shortening* of the nickel was now found, cobalt elongating but not so much as iron. This observation is, I believe, new, the fact was first noticed by me on September 9, 1873, but some uncertainty as to the reliability of the apparatus I then used led me to put the matter aside till July, 1876, when the experiments were repeated, and the fact that cobalt elongates and nickel retracts under magnetisation, was fully confirmed.

The multiplying apparatus that was found to yield most satisfactory results was a simple form of optical lever, a mirror vertically fixed over the fulcrum of a lever of the first order, and reflecting a scale at some distance into an observing telescope. The apparatus will be more fully described in the report that will be presented next year; a committee, with a small money grant, having been appointed at a previous meeting of the Association to investigate this and certain other molecular changes accompanying the magnetisation of iron, described by the author at the Bradford meeting of the Association.

The results so far obtained may be summed up as follows:—However often the current traverses the helix around the bar of *cobalt*, the elongation is practically the same after the first current, and amounts to about two-thirds of the elongation produced in an iron bar of the same dimensions. In my measurement the elongation of the iron amounted to about 1-260,000th of its length for the maximum magnetisation; the iron elongated 5 scale divisions, and the cobalt 3, or 1-425,000th of its length. With *nickel*, the retraction on the same scale was 10, or twice the elongation of the iron, or about 1-130,000th of the length of the bar. Reversing the current made no alteration in the results. The index returned promptly to zero on the cessation of the current. The retraction of the nickel was so instantaneous that it was only by noting the scale-reading that any motion could be discovered to have taken place. The helix in all cases was the whole length of the bars.

Inclosing the bars in a vessel of water terminating in a capillary tube (the stem of a mercurial thermometer of extremely fine bore), and surrounding the vessel by a powerful magnetising helix, no motion of the water-level in the capillary tube was noticed with iron and cobalt on the making, breaking, or reversing the current in the helix; with nickel no motion was observed on making, and a barely perceptible, but still definite, fall of the index, equal to about 1-10,000,000th of the volume of the bar, occurred on breaking, which was more clearly seen by frequent interruptions of the current.

The "magnetic tick" is heard loudly with cobalt and nickel, as well as iron, the former giving a very clear metallic click on magnetisation.

I am much indebted to the kindness of Messrs. Johnson and Matthey for the bars of nickel and cobalt (9½ inches long and 1 inch diameter) with which the experiments were conducted, and also to Mr. Gore, F.R.S., for the loan of a longer bar of nickel. Experiments are now in progress to determine the effect of temperatures and longitudinal tensions on the result.

Preliminary experiments show, that raising the temperature of the iron and cobalt bars some 50° C. makes a scarcely appreciable difference in the amount they elongate, whereas, when nickel is heated the same amount, its retraction on magnetisation is, as might be expected, considerably diminished, being about three-fourths of the amount occurring at the temperature of the air. Owing to the short length of the bars, the actual elongation measured was, in the case of the cobalt, only the 1-46,000th of an inch, but a difference of 100,000th of an inch could confidently be measured.

SUNLIGHT AND SKYLIGHT AT HIGH ALTITUDES

At the Southampton meeting of the British Association, Captain Abney read a paper in which he called attention to the fact that photographs taken at high altitudes show skies that are nearly black by comparison with bright objects projected against them, and he went on to show that the higher above the sea-level the observer went, the darker the sky really is and the fainter the spectrum. In fact, the latter shows but little more than a band in the violet and ultra-violet at a height of 8500 feet, whilst at sea-level it shows nearly the whole photographic spectrum. The only reason of this must be particles of some reflecting matter from which sunlight is reflected. The author refers this to watery stuff of which nine-tenths is left behind at the altitude at which he worked. He then showed that the brightness of the ultra-violet of direct sunlight increased enormously the higher the observer went, but only to a certain point, for the spectrum suddenly terminated about 2940 wave-length. This abrupt absorption was due to extra atmospheric causes and perhaps to space. The increase in brightness of the ultra-violet was such that the usually invisible rays L, M, N could be distinctly seen showing that the visibility of these rays depended on the intensity of the radiation. The red and ultra-red part of the spectrum was also considered. He showed that the absorption lines were present in undiminished force and number at this high altitude, thus placing their origin to extra atmospheric causes. The absorption from atmospheric causes of radiant energy in these parts he showed was due to "water-stuff," which he hesitated to call aqueous vapour, since the banded spectrum of water was present, and not lines. The B and A line he also stated could not be claimed as telluric lines, much less as due to aqueous vapour, but must originate between the sun and our atmosphere. The author finally confirmed the presence of benzene and ethyl in the same region. He had found their presence indicated in the spectrum at sea-level, and found their absorption lines with undiminished intensity at 8500 feet. Thus without much doubt hydrocarbons must exist between our atmosphere and the sun, and it may be in space.

Prof. Langley, following Capt. Abney, observed: The very remarkable paper just read by Captain Abney has already brought information, upon some points which the one I am about, by the courtesy of the Association, to present, leaves in doubt. It will be understood then that the references here are to his published memoirs only, and not to what we have just heard.

The solar spectrum is so commonly supposed to have been mapped with completeness, that the statement that much more than one half its extent is not only unmapped but nearly unknown, may excite surprise. This statement is, however, I think, quite within the truth, as to that almost unexplored region discovered by the elder Herschel, which lying below the red and invisible to the eye, is so compressed by the prism, that though its aggregate heat effects have been studied through the thermopile, it is only by the recent researches of Capt. Abney that we have any certain knowledge of the lines of absorption there, even in part. Though the last named investigator has extended our knowledge of it to a point much beyond the lowest visible ray, there yet remains a still remoter region, more extensive than the whole visible spectrum, the study of which has been entered on at Alleghany, by means of the linear Bolometer.

The whole spectrum, visible and invisible, is powerfully affected by the selective absorption of our atmosphere, and that of the sun; and we must first observe that could we get outside our earth's atmospheric shell, we should see a second and very different spectrum, and could we afterward remove the solar atmosphere also, we should have yet a third, different from either. The charts exhibited show:—

1st. The distribution of the solar energy as we receive it, at the earth's surface, throughout the entire invisible as well as visible portion, both on the prismatic and normal scales. This is what I have principally to speak of now, but this whole first research is but incidental to others upon the spectra before any absorption, which though incomplete, I wish to briefly allude to later. The other curves then indicate.

2nd. The distribution of energy before absorption by our own atmosphere.

3rd. This distribution at the photosophere of the sun.

The extent of the field, newly studied, is shown by this drawing (chart exhibited). Between H in the extreme violet, and A in the furthest red, lies the visible spectrum, with which we are familiar, its length being about 4,000 of Ångstrom's units. If, then, 4,000 represent the length of the visible spectrum, the chart shows that the region below extends through 24,000 more, and so much of this as lies below wavelength, 12,000, I think, is now mapped for the first time.

We have to $\lambda = 12,000$, relatively complete photographs, pub-

---

[1] *Phil. Mag.*, January, 1874.

lished by Capt. Abney, but except some very slight indications by Lamansky, Desains, and Mouton, no further guide.

Deviations being proportionate to abscissae, and measured solar energies to ordinates, we have here (1) the distribution of energy in the prismatic and (2) its distribution in the normal spectrum. The total energy is in each case proportionate to the area of the curve, (the two very dissimilar curves inclosing the same area), and on each, if the total energy be roughly divided into four parts, one of these will correspond to the visible, and three to the invisible or ultra-red part. The total energy at the ultra violet end, is so small then as to be here altogether negligable.

We observe that (owing to the distortion introduced by the prism) the maximum ordinate representing the heat in the prismatic spectrum is, as observed by Tyndall, below the red, while upon the normal scale this maximum ordinate is found in the orange.

I would next ask your attention to the fact that in either spectrum, below λ = 12,000 are most extraordinary depressions and interruptions of the energy, to which, as will be seen, the visible spectrum offers no parallel. As to the agent producing these great gaps, which so strikingly interrupt the continuity of the curve, and as you see, in one place, cut it completely in two, I have as yet obtained no conclusive evidence. Knowing the great absorption of water vapor in this lowest region, as we already do, from the observations of Tyndall, it would, *a priori*, seem not unreasonable to look to it as the cause. On the other hand, when I have continued observations from noon to sunset, making successive measures of each ordinate, as the sinking sun sent its rays through greater depths of absorbing atmosphere; I have not found these gaps increasing, as much as they apparently should, if due to a terrestrial cause, and so far as this evidence goes, they might be rather thought to be solar. But my own means of investigation are not so well adapted to decide this important point, as those of photography, to which we may yet be indebted for our final conclusion.

I am led from a study of Capt. Abney's photographs of the region between λ = 8,000 and λ = 12,000, to think that these gaps are produced by the aggregation of finer lines, which can best be discriminated by the camera, an instrument, which where it can be used at all, is far more sensitive than the bolometer; while the latter, I think, has on the other hand some advantage in affording direct and trustworthy measures of the amount of energy inhering in each ray.

One reason why the extent of this great region has been so singularly underestimated, is the deceptively small space into which it appears to be compressed by the distortion of the prism. To discriminate between these crowded rays I have been driven to the invention of a special instrument. The bolometer, which I have here, is an instrument depending upon principles which I need not explain at length, since all present may be presumed to be familiar with the success which has before attended their application in another field, in the hands of the President of this Association.

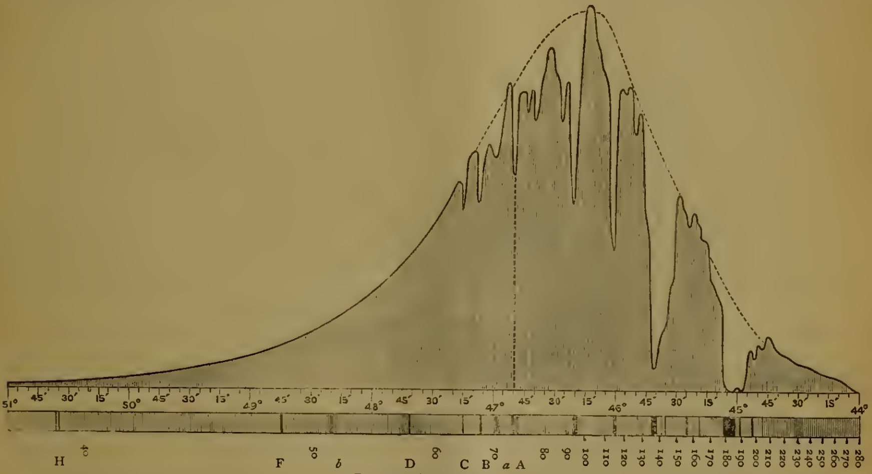


Fig. 1.—Prismatic Spectrum.

I may remark, however, that this special construction has involved very considerable difficulties and long labour. For the instrument here shown, platinum has been rolled by Messrs. Tiffany, of New York, into sheets, which as determined by the kindness of Professor Rood, reach the surprising tenuity of less than $\frac{1}{25000}$ of an English inch (I have also iron rolled to $\frac{1}{15000}$ inch), and from this platinum a strip is cut $\frac{1}{125}$ of an inch wide. This minute strip, forming one arm of a Wheatstone's bridge, and thus perfectly shielded from air currents, is accurately centred by means of a compound microscope, in this truly turned cylinder, and the cylinder itself is exactly directed by the arms of this Y.

The attached galvanometer responds readily to changes of temperature, of much less than $\frac{1}{100000}$° Fah. Since it is one and the same solar energy, whose manifestations we call "light" or "heat," according to the medium which interprets them, what is "light" to the eye is "heat" to the bolometer, and what is seen as a dark line by the eye is felt as a cold line by the sentient instrument. Accordingly if lines analogous to the dark "Frauenhofer lines" exist in this invisible region they will appear (if I may so speak), to the bolometer as cold bands, and this hair-like strip of platina is moved along in the invisible part of the spectrum, till the galvanometer indicates the all but infinitesimal change of temperature caused by its contact with such a "cold band." The whole work, it will be seen, is necessarily very slow; it is in fact a long groping in the dark, and it demands extreme patience. A portion of its results are now before you.

The most tedious part of the whole process, has been the determination of the wave-lengths. It will be remembered that we have (except through the work of Capt. Abney, already cited, and perhaps of M. Mouton), no direct knowledge of the wave-lengths in the infra-red prismatic spectrum, but have hitherto inferred them from formulas like the well-known one of Cauchy's, all which known to me appear to be here found erroneous by the test of direct experiment; at least in the case of the prism actually employed.

I have been greatly aided in this part of the work by the remarkable concave gratings lately constructed by Prof. Rowland of Baltimore, one of which I have the pleasure of showing you. (Instrument exhibited.)

The spectra formed by this, fall upon a screen in which is a fine slit, only permitting nearly homogeneous rays to pass, and these, which may contain the rays of as many as four overlapping spectra, are next passed through a rock-salt or glass prism placed with its refracting edge parallel to the grating lines. This sorts out the different narrow spectral images, without danger of overlapping, and after their passage through the prism we find them again and fix their position by means of the bolometer, which for this purpose is attached to a special kind of spectrometer, where its platinum thread replaces the reticule of the ordinary telescope. This is very difficult work, especially in the lowermost spectrum, where I have spent over two weeks of consecutive labour, in fixing a single wave-length.

The final result is I think worth the trouble however, for as you see here, we are now able to fix with approximate precision, and by direct experiment, the wave-length of every prismatic spectral ray. The terminal ray of the solar spectrum, whose presence has been certainly felt by the bolometer, has a wave-length of about 28,000 (or is nearly two octaves below the "great A" of Frauenhofer).

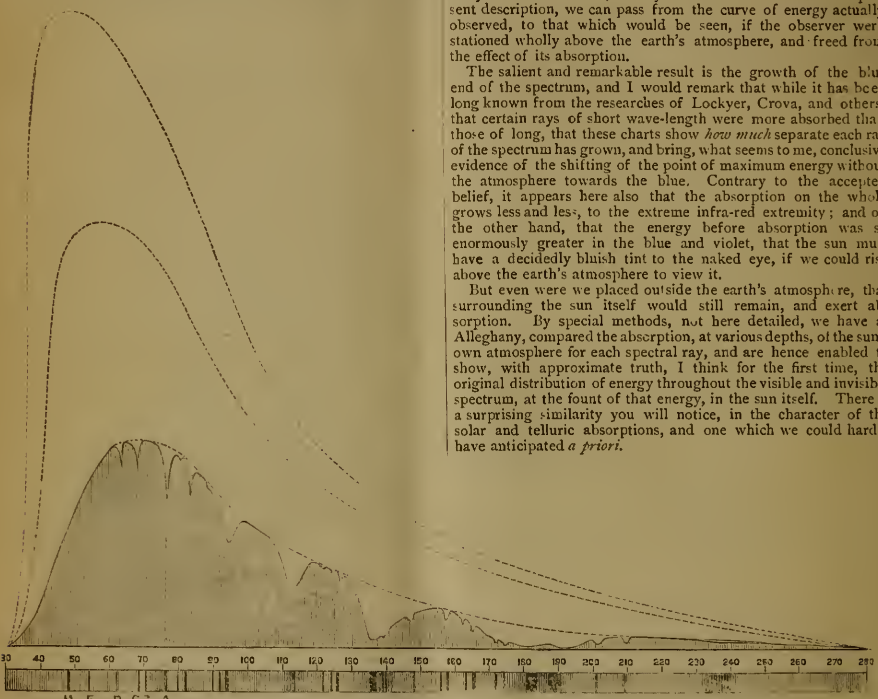


Fig. 2.—Normal Spectrum (at sea-level).

So far it appears only that we have been measuring *heat*, but I have called the curve that of solar "energy," because by a series of independent investigations, not here given, the selective absorption of the silver, the speculum-metal, the glass and the lamp-black (the latter used on the bolometer-strip), forming the agents of investigation, has been separately allowed for. My study of lamp-black absorption, I should add in qualification, is not quite complete, I have found it quite transparent to certain infra-red rays, and it is very possible that there may be some faint radiations yet to be discovered even below those here indicated.

In view of the increased attention that is doubtless soon to be given to this most interesting but strangely neglected region, and which by photography and other methods, is certain to be fully mapped hereafter, I can but consider this present work less as a survey than as a sketch of this great new field, and it is as such only that I here present it.

All that has preceded is subordinate to the main research, on which I have occupied the past two years at Alleghany, in comparing the spectra of the sun at high and low altitudes, but which I must here touch upon briefly. By the generosity of a friend of the Alleghany Observatory, and by the aid of Gen. Hazen, Chief Signal Officer of the U.S. army, I was enabled last year to organise an expedition to Mount Whitney in South California, where the most important of these latter observations were repeated at an altitude of 13,000 feet. Upon my return I made a special investigation upon the selective absorption of the sun's atmosphere, with results which I can now only allude to.

By such observations, but by methods too elaborate for present description, we can pass from the curve of energy actually observed, to that which would be seen, if the observer were stationed wholly above the earth's atmosphere, and freed from the effect of its absorption.

The salient and remarkable result is the growth of the blue end of the spectrum, and I would remark that while it has been long known from the researches of Lockyer, Crova, and others, that certain rays of short wave-length were more absorbed than those of long, that these charts show *how much* separate each ray of the spectrum has grown, and bring, what seems to me, conclusive evidence of the shifting of the point of maximum energy without the atmosphere towards the blue. Contrary to the accepted belief, it appears here also that the absorption on the whole grows less and less, to the extreme infra-red extremity; and on the other hand, that the energy before absorption was so enormously greater in the blue and violet, that the sun must have a decidedly bluish tint to the naked eye, if we could rise above the earth's atmosphere to view it.

But even were we placed outside the earth's atmosphere, that surrounding the sun itself would still remain, and exert absorption. By special methods, not here detailed, we have at Alleghany, compared the absorption, at various depths, of the sun's own atmosphere for each spectral ray, and are hence enabled to show, with approximate truth, I think for the first time, the original distribution of energy throughout the visible and invisible spectrum, at the fount of that energy, in the sun itself. There is a surprising similarity you will notice, in the character of the solar and telluric absorptions, and one which we could hardly have anticipated *a priori*.

Here too, violet has been absorbed enormously more than the green, and the green than the red, and so on, the difference being so great, that if we were to calculate the thickness of the solar atmosphere on the hypothesis of a uniform transmission, we should obtain a very thick atmosphere, from the rate of absorption in the infra-red alone, and a very thin one from that in the violet alone.

But the main result, seems to be still this, that as we have seen in the earth's atmosphere, so we see in the sun's, an enormous and progressive increase of the energy towards the shorter wave-lengths. This conclusion, which I may be permitted to remark, I anticipated in a communication published in the *Comptes Rendus* of the Institute of France as long since as 1875, is now fully confirmed, and I may mention that it is so also by direct photometric methods, not here given.

If then we ask how the solar photosphere would appear to the eye, could we see it without absorption, these figures appear to show conclusively that it would be *blue*. Not to rely on any assumption, however, we have by various methods at Alleghany, reproduced this colour.

Thus (to indicate roughly the principle used), taking three Maxwell's discs, a red, green, and blue, so as to reproduce white, we note the three corresponding ordinates at the earth's surface spectrum, and comparing these with the same ordinates in the curve giving the energy at the solar surface; we re-arrange the discs, so as to give the proportion of red, green, and blue which would be seen *there*, and obtain by their revolution a tint which must approximately represent that at the photosphere, and which is most similar to that of a blue near Frauenhofer's "F."

The conclusion then is that while all radiations emanate from the solar surface, including red and infra-red, in greater degree than we receive them, that the blue end is so enormously greater in proportion, that the proper colour of the sun, as seen at the photosphere, is blue—not only "bluish," but positively and distinctly blue; a statement which I have not ventured to make from any conjecture, or on any less cause than on the sole ground of long continued experiments, which, commenced some seven years since, have within the past two years irresistibly tended to the present conclusion.

The mass of observations on which it rests must be reserved for more detailed publication elsewhere, at present I can only thank the Association for the courtesy which has given me the much prized opportunity of laying before them this indication of methods and results.

UNDERGROUND TEMPERATURE[1]

II.

E. We now proceed to a Comparison of Results.

THE localities at which definite results have been obtained may thus be classified:—

1. Metallic mines. 2. Coal mines. 3. Wells and wet borings. 4. Tunnels.

1. The mines at Przibram in Bohemia, with a depth of 1900 feet, are in very quartzose rock, and give a very slow rate of increase, viz. 1° F in 135 feet. As all the shafts are in lofty hills, an allowance of $\frac{1}{15}$ may be made for convexity, leaving 1° F. in 126 feet. Quartz is found by Prof. Herschel to have a conductivity of about ·0086.

The mines at Schemnitz in Hungary, with a depth of 1368 feet, give an average rate of 1° F. in 74 feet, the rock being a green hornblende-andesite (in German, *Grünstein-Trachyt*), which is a compact, fine-grained, crystalline, more or less vitreous rock. Prof. Lebour estimates its conductivity as being probably nearly the same as that of Calton Hill trap-rock, which Prof. Herschel found to be about ·0029.

2. The principal results from coal mines are as follows:—

The mines of the Société Cocqueril at Seraing (Belgium), with a depth of 1657 feet, give an average rate of 1° F. in 50 feet. The rock is coal shale. Prof. Herschel found for shale the low conductivity ·0019.

The mines of Anzin, in the north of France, with a depth of 658 feet, gave in the deepest shaft an increase of 1° in 47 feet.

Rosebridge Colliery, near Wigan, with a depth of 2445 feet, gave a mean rate of 1° in 54 feet.

The four following are in the East Manchester coalfield:—

Astley Pit, Dukinfield, with a depth of 2700 feet, gave a mean rate of 1° in 72 feet.

Ashton Moss Colliery, with a depth of 2790 feet, gave 1° in 77 feet.

Bredbury Colliery, with a depth of 1020 feet, gave 1° in 78·5 feet.

Nook Pit, with a depth of 1050 feet, gave 1° in 79 feet.

South Hetton Colliery, Durham, with a depth of 1929 feet, including a bore hole at bottom, gives very consistent observations at various depths, and an average rate of 1° in 57·5 feet.

Boldon Colliery, between Newcastle and Sunderland, with a depth of 1514 feet, and excellent conditions of observation, gives an average rate of 1° in 49 feet.

Kingswood Colliery, near Bristol, with a depth of 1769 feet, and remarkable consistency between observations at various points, gives 1° in 68 feet.

Prof. Phillips' observations in Monkwearmouth Colliery, published in *Phil. Mag.* for December 1834, showed a temperature of 71·2 in a hole bored in the floor of a recently exposed part at the depth of 1584 feet. The surface of the ground is 87 feet above high water, and the mean temperature of the air is assumed by Prof. Phillips to be 47·6. If, as usual, we add 1° to get the soil temperature, instead of assuming, as Prof. Phillips does, that the temperature 100 feet deep is identical with the air temperature at the surface, we obtain a rate of increase of 1° in 70 feet.

3. The following are the most trustworthy results from wells and borings:—

The Sperenberg bore, near Berlin, in rock salt, with a depth of 3492 English feet, to the deepest reliable observation, gave an average of 1° in 51·5 feet. This result is entitled to special weight, not only on account of the great depth, but also on account of the powerful means employed to exclude convection.

Rock salt, according to Prof. Herschel, has the very high conductivity ·0113.

Three artesian well in the chalk of the Paris Basin gave the following results:—

	Feet.	Rate. Feet.
St. Andre, depth of observation	830	1 in 56·4
Grenelle	1312	1 in 56·9
Military School	568	1 in 56·2

An artesian well at St. Petersburg, in the Lower Silurian strata, with a depth of 656 feet, gave about 1° in 44 feet.

A well sunk at Vakoutsk, in Siberia, to the depth of 540 feet, disclosed the fact that the ground was permanently frozen to this depth, and probably to the depth of 700 feet. The rate of increase of temperature was 1° in 52 feet.

Of the English wells in which observations have been taken, the most important is that at Kentish Town, in which Mr. G. J. Symons, F.R.S., has taken observations to the depth of 1100 feet. The temperatures at different depths form a smooth series, and have been confirmed by observations repeated at long intervals. The only question that can arise as to the accuracy of the results is the possibility of their being affected by convection.

The well is 8 feet in diameter, with brickwork to the depth of 540 feet, and this part of it is traversed by an iron tube 8 inches in diameter, which is continued to the depth of more than 1300 feet from the surface. The tube is choked with mud to the depth of about 1080 feet, so that the deepest observations were taken under 20 feet of mud. The temperature at 1100 feet was 69°·9, and by combining this with the surface temperature of 49°·9 observed at the Botanic Gardens, Regent's Park, we obtain a rate of 1° in 55 feet. These data would give at 250 feet a calculated temperature of 54·5, whereas the temperature actually observed at this depth was 56·1, or 1°6 higher; the temperature at 300 feet and at 350 feet being also 56·1. This seems to indicate convection, but it can be accounted for by convection in the 8-foot well which surrounds the tube, and does not imply convection currents within the tube. Convection currents are much more easily formed in water columns of large diameter than in small ones, and the 20 feet of mud at the bottom give some security against convection at the deepest point of observation. It is important to remark that the increase from 1050 to 1100 feet is rather less than the average instead of being decidedly greater, as it would be if there were convection above, but not in, the mud. The rate of 1° in 55 feet may therefore be adopted as correct.

The strata consist of tertiary strata, chalk (586 feet thick), upper greensand, and gault.

The Kentish Town temperature at the depth of 400 feet (58°) is confirmed by observations in Mr. Sich's well at Chiswick, which is 395 feet deep, and has a temperature varying from 58° to 57°·5.

The Bootle well, belonging to the Liverpool Waterworks, is 1302 feet deep, and the observations were taken in it during the sinking. The diameter of the bore is 24 inches, and convection might have been suspected but for the circumstance that there was a gradual upward flow of water from the bottom, which escaped from the upper part of the well by percolation to an underground reservoir near at hand. This would check the tendency to downflow of colder water from the top; and as the observations of temperature were always made at the bottom, they would thus be protected against convective disturbance.

The temperature at 226 feet was 52°, at 750 feet 56°, at 1302 feet 59°, giving by comparison of the first and last of these a mean rate of 1° in 154 feet. The circumstance that the boring

---

[1] Continued from p. 567.

ceased for six weeks at the depth of 1004 feet, and the temperature fell during this interval from 58°·1 to 57°·0, would seem to indicate an elevation of 1° due to the heat generated by the boring tool. An assumed surface temperature of 49° (only 0°·9 lower than that of the Botanic Gardens in London) would give by comparison with 57°, at 1004 feet, a rate of 1° in 125½ feet, and by comparison with 59°, at 1302 feet, a rate of 1° in 130 feet, which last may be adopted as the best determination. The rock consists of the pebble beds of the Bunter or Lower Trias, and the boring was executed at the rate of nearly 100 feet per month.

The boring at Swinderby, near Scarle (Lincoln), in search of coal, was carried to a depth of 2000 feet, with a diameter at the lower part of only 3⅓ inches—a circumstance favourable to accuracy, both as impeding convection and as promoting the rapid escape of the heat of boring. The temperature at the bottom was 79°, the water having been undisturbed for a month, and this by comparison with an assumed surface temperature of 50° gives a rate of 1° in 69 feet.

The rocks are Lower Lias, New Red Marl (569 feet thick), New Red Sandstone (790 feet thick), Red Marl, and earthy Limestone

The following results have been obtained from shallow borings. The first three were made under Sir William Thomson's direction, with a thermometer which could be read by estimation to hundredths of a degree:—

Blythswood bore, near Glasgow, with a depth of 347 feet, gave a very regular increase of 1° in 50 feet.

Kirkland Neuk bore, in the immediate vicinity of the above, gave consistent observations at different seasons of the year from 180 feet to the bottom (354 feet), the rate being 1° in 53 feet. This bore passed through coal which had been "very much burned or charred."

South Balgray bore, near Glasgow, and north of the Clyde, with an available depth of 525 feet, gave by comparing the temperature at the bottom with that at 60 feet a rate of 1° in 41 feet.

Shale extends continuously from 390 to 450 feet from the surface, and the increase in these 60 feet of shale was 2°·02, which is at the rate of 1° in 30 feet. This rapid increase agrees with the fact that shale has very low conductivity, averaging ·0019 in Prof. Herschel's experiments.

The only small bore remaining to be mentioned is that at Manegaon, in India, which had 310 feet available, and gave by comparing the temperature at this depth with that at 60 feet a rate of 1° in 68 feet. The rocks consist of fine softish sandstones and hard silty clays, the dip being 10°.

4. *Tunnels.*—The Mont Cenis tunnel, which is about seven miles long, is at a depth of exactly a mile (5280 feet) beneath the crest of Mont Fréjus overhead. This was the warmest part of the tunnel, and had a temperature of 85°·1 F. The mean air temperature at the crest overhead was calculated by the engineer of the tunnel, M. Giordano, by interpolating between the known temperature of the hill of San Theodale and that of the city of Turin, the former being 430 metres higher, and the latter 2650 metres lower, than the point in question. It is thus calculated to be − 2°·6 C. or 27°·3 F. If, according to our usual rule, we assume the ground to be 1° warmer than the air, we have 28°·3 to compare with 85°·1. This gives a rate of 1° in 93 feet; but, inasmuch as the convexity of the surface increases the distance between the isotherms, a correction will be necessary before we can fairly compare this result with rates under level ground. As a rough estimate we may take ⅞ of 93, and adopt 1° in 79 feet, as the corrected result.

"The rocks on which the observations have been made are absolutely the same, geologically and otherwise, from the entrance to the tunnel, on the Italian side, for a distance of nearly 10,000 yards. They are not faulted to any extent, though highly inclined, contorted, and subjected to slight slips and slides. They consist, to a very large extent indeed, of silicates, chiefly of alumina, and the small quantity of lime they contain is a crystalline carbonate."

The St. Gothard Tunnel, which has a length of about nine miles, has been subjected to much more minute observation, a skilled geologist, Dr. Stapff, having, under Government direction, devoted his whole time to investigating its geology and physics. He not only observed the temperature of the rock in the tunnel at very numerous points, but also determined, by observations of springs, the mean temperatures of the surface of the mountain at various points, and compared these with an empirical formula for air temperature deduced from the known mean temperatures of the air at Göschenen, Andermatt, Airolo, and the Hospice of St. Bernard. He infers from his comparisons a considerable excess of soil above air temperature, increasing from 2° C. at the ends of the tunnel to 6° C. at the crest of the mountain over the centre of the tunnel. The highest temperature of the rocks in the tunnel was at this central part, and was about 30°·6 C. or 87° F. The soil temperature at the crest above it was about − 0°·6 C., or 31° F., giving a difference of 56° F. The height of the crest above sea-level was about 2850 m., and that of the tunnel at this part 1150 m., giving a difference of 1700 m. or 5578 feet. The rate of increase here is, therefore, about 1° F. in 100 feet; and if we apply the same correction for convexity as in the case of the Mont Cenis Tunnel, this will be reduced to about 1° F. in 87 feet, as the equivalent rate under a level surface. From combining his observations in all parts of the tunnel through the medium of empirical formulæ, Dr. Stapff deduces an average rate of 1° F. for every 88 feet measured from the surface directly overhead. Where the surface is a steep ridge, the increase was less rapid than this average; where the surface was a valley or plain, the increase was more rapid. As this average merely applies to the actual temperatures, the application of a correction for the general convexity of the surface would give a more rapid rate. If we bring the isotherms nearer by one part in 15, which seems a fair assumption, we shall obtain a rate of 1° F. in 82 feet.

Collecting together all the results which appear reliable, and arranging them mainly in the order of their rates of increase, but also with some reference to locality, we have the following list:—

		Depth feet	Feet for 1° F.
Bootle waterworks (Liverpool		1392	... 130
Przibram mines (Bohemia)		1900	... 126
St. Gothard tunnel		5578	... 82
Mont Cenis tunnel		5280	... 79
Talargoch lead mine (Flint)		1041	... 80
Nook Pit, Colliery ...	East Manchester coalfield.	... 1050	... 79
Bredbury ,, ...		.. 1020	... 78½
Ashton Moss ,, ...		.. 2790	... 77
Denton ,, ..		... 1317	... 77
Astley Pit, Dukinfield		... 2700	... 72
Schemnitz mines (Hungary)		1368	.. 74
Scarle boring (Lincoln)		2000	... 69
Manegaon boring (India)		310	... 68
Pontypridd colliery (S. Wales)		855	... 76
Kingswood colliery (Bristol)		1769	... 68
Radstock ,, (Bath)		620	... 62
Paris artesian well, Grenelle		1312	... 57
,, ,, St. André		830	... 56
,, ,, Military School ...		568	... 56
London ,, Kentish Town		1100	... 55
Rosebridge colliery (Wigan)		2445	... 54
Yakoutsk, frozen ground (Siberia)		540	... 52
Sperenberg, boring in salt (Berlin)		3492	... 51½
Seraing collieries (Belgium)		1657	... 50
Monkwearmouth collieries (Durham) ...		1584	... 70
South Hetton ,, ,, ...		1929	... 57½
Boldon ,, ,, ...		1514	... 49
Whitehaven ,, (Cumberland)		1250	... 45
Kirkland Neuk bore (Glasgow)		354	... 53
Blythswood ,, ,, ...		347	... 50
South Balgray ,, ,, ...		525	... 41
Anzin collieries (North of France)		658	.. 47
St. Petersburg, well (Russia)		656	... 44
Carrickfergus, shaft of salt mine (Ireland)		770	... 43
,, ,, ,,		570	... 40
Slitt mine, Weardale (Northumberland) ...		660	... 34

The depth stated is in each case that of the deepest observation that has been utilised.

F. IN DEDUCING A MEAN FROM THESE VERY VARIOUS RESULTS, it is better to operate not upon the number of feet per degree, but upon its reciprocal—the increase of temperature per foot. Assigning to the results in the foregoing list weights proportional to the depths, the mean increase of temperature per foot is found to be ·01563, or about $\frac{1}{64}$ of a degree per foot—that is, 1° F. in 64 feet.

It would be more just to assign greater weight to those single results which represent a large district or an extensive group of mines, especially where the data are known to be very accurate. Doubling the weights above assigned to Przibram, St. Gothard, Mont Cenis, Schemnitz, Kentish Town, Rosebridge, and Seraing, and quadrupling that assigned to Sperenberg, no material difference is made in the result. The mean still comes out 1° F. in 64 feet, or more exactly ·01566 of a degree per foot.

This is a slower rate than has been generally assumed, but it has been fairly deduced from the evidence contained in the Committee's Reports; and there is no reason to throw doubt on the results in the upper portion of the above list more than on those in its lower portion. Any error that can reasonably be attributed to the data used in the calculations for the St. Gothard Tunnel and for the numerous deep mines of the East Manchester coalfield, will have only a trifling effect on the rates of increase assigned to these localities.

To obtain an approximation to the rate at which heat escapes annually from the earth, we will first reduce the above rate of increase ·01566 to Centigrade degrees per centimetre of depth. For this purpose we must multiply by ·0182, giving ·000285.

To calculate the rate of escape of heat, this must be multiplied by the conductivity.

The most certain determinations yet made of the conductivity of a portion of the earth's substance are those deduced by Sir William Thomson by an indirect method, involving observations of underground thermometers at three stations at Edinburgh, combined with laboratory measurement of the specific heats and densities of the rocks in which the thermometers were planted. The specific heats were determined by Regnault, and the densities by Forbes. Specific heats and densities can be determined with great accuracy in the laboratory, but the direct determination of conductivity in the laboratory is exceedingly difficult, it being almost impossible to avoid sources of error which make the conductivity appear less than it really is.

Prof. Herschel, in conjunction with a Committee of the British Association, has made a very extensive and valuable series of direct measurements of the conductivities of a great variety of rocks, and has given additional certainty to his results by selecting as two of the subjects of his experiments the Calton Hill Trap and Craigleith sandstone, to which Sir William Thomson's determinations apply.

From combining Prof. Herschel's determinations with those of Sir Wm. Thomson, ·0058 is adopted as the mean conductivity of the outer crust of the earth, which, being multiplied by the mean rate of increase, ·000285, gives

$$16330 \times 10^{-10}$$

as the flow of heat in a second across a square centimetre. Multiplying by the number of seconds in a year, which is approximately 31½ millions, we have

$$1633 \times 315 \times 10^{-4} = 41{\cdot}4.$$

This, then, is our estimate of the average number of gramme-degrees of heat that escape annually through each square centimetre of a horizontal section of the earth's substance.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The lists of Boards of Studies for the first time include the separate Boards of Physics and Chemistry, and of Biology and Geology, as constituted by the new Statutes. The Woodwardian Professor appears in both Boards. The Physiology Professor, not being yet appointed, only appears in brackets; the same is the case with the Professor of Pathology in the Board of Medical Studies.

The new Statute B having been finally approved, determines that in 1883 and 1884, a sum of between 5000*l.* and 6000*l.* in each year will become available for University purposes from College revenues, subject only to deduction of 40*l.* by each College for each Professorial Fellowship held at the College.

The Professors of Physiology, Pathology, and Mental Philosophy and Logic are to be appointed in such order as the University may think fit, as soon as sufficient funds can be provided conveniently for the purpose from the common University fund, or from other sources. The Professors of Physiology and of Pathology are not to undertake the private practice of medicine or surgery. The stipends are fixed at 800*l.* for these two Professors, and 700*l.* for the Professor of Mental Philosophy.

The appointment of Readers is similarly dependent on the convenient provision of funds. Thus, until the Council of the Senate has published its recommendations, nothing certain can be said as to the objects upon which it will be thought wisest first to expend the new funds accruing. But it must not be forgotten that a considerable amount of the new income will be required to pay the increased stipends of present professors.

Prof. Liveing will lecture on the General Principles of Chemistry this term, and also take practical classes in spectroscopic analysis. Prof. Dewar will lecture on Physical Chemistry, and Tutorial lectures will be given in connection with this course by Mr. A. Scott, Prof. Dewar's assistant. Demonstrations in volumetric chemistry will be given by one of the demonstrators.

Lord Rayleigh will lecture on Electrical Measurements to advanced students; Mr. Glazebrook will give demonstrations on Electricity and Magnetism, and Mr. Shaw on Heat in the Cavendish Laboratory. Mr. Trotter will give an elementary course on Electricity and Magnetism at Trinity College, and also a course on Optics and Light.

Mr. Vines will lecture on the Physiology of Plants, at Christ's College, in connection with practical work, and will also give an elementary course at the New Museums, especially for medical students. The Assistant Curator of the Herbarium, Mr. T. H. Corry, B.A., of Caius College, will give a series of demonstrations on the natural orders of plants.

Prof. Stuart will lecture on Mechanism and Applied Mechanics, and the workshops and drawing office will be opened to pupils on October 13. At Gonville and Caius College one or more Entrance Scholarships of values varying from 40*l.* to 80*l.* according to merit of candidates, will be awarded in Natural Science by an examination beginning on January 8 next. They are only open to candidates under nineteen years of age on the first day of examination, and are tenable only for one year, after which a foundation scholarship may be awarded. The subjects are Physics, Chemistry, Biology, and Animal Physiology; two subjects at least are required, Chemistry being essential. Particulars of subjects may be learnt on application to the Senior Tutor, Rev. A. W. Steel. Scholarships may also be awarded for Mathematics and Natural Science combined.

The examination for Entrance Scholarships at Emmanuel College will commence on January 12. They are tenable in the first instance for two years. The subjects in Natural Science are Chemistry, Physics (including Dynamics and Hydrostatics), Elementary Biology, and Geology and Mineratogy. Candidates may also obtain scholarships for Mathematics and Natural Science combined. Mr. W. Chawner, the tutor, will supply all information.

Mr. A. Sedgwick, of Trinity College, Cambridge, will conduct the classes in Morphology which Prof. Balfour had announced for the present term.

SCIENTIFIC SERIALS

The Journal of Anatomy and Physiology (*Normal and Pathological*), vol. xvi. pt. iv., July, 1882, contains:—Observations in comparative myology, by Dr. Hans Gadow. The first section of this interesting paper is devoted to the important subject of a scientific nomenclature for muscles.—On fat embolism, by Drs. R. Saundby and G. Barling (with a plate).—On Micrococcus poisoning, by Dr. Alex. Ogston.—On the action of saline cathartics, by Dr. M. Hay (D and E series of experiments).—On a variety of pulmonary lobation and its relation to the thoracic parietes, as illustrated by comparative anatomy and abnomalities in the human subject, by Dr. W. Allen.—Prof. Gegenbaur, critical remarks on polydactyly as atavism; translated by Drs. Garson and Gadow.

The American Naturalist for August, 1882, contains—On the compass plant, by B. Alvord.—On the development of the tree toad, by M. H. Hinckley.—On some entomostraca of Lake Michigan and adjacent waters, by S. A. Forbes.—Organic physics, by Charles Morris.—The Editor's table.—Recent literature.

The same for September, 1882, contains—The methods of microscopical research adopted in the Zoological Station in Naples, by C. O. Whitman.—Notes on the habits of the "Savannah cricket frog," by C. C. Abbott.—On the evolution of forms from the Clinton to the Niagara group, by E. N. S. Ringueberg.—On hypnotism in animals, by Dr. W. Prentiss.

The Transactions and Proceedings of the New Zealand Institute for 1882, being vol. xiv., edited by Dr. J. Hector, F.R.S., and published at Wellington, May, 1882, have just reached us. They form a royal octavo volume of over 600 pages and 39 plates.

Among the more important memoirs may be mentioned the following:—On historical incidents and traditions of the Maoris, Part II.—Contributions to a better knowledge of the Maori race, Part IV., and on the fine perception of colour of the ancient Maori, by W. Colenso.—On the causes leading to the extinction of the Maoris, by Dr. A. K. Newman.—Several memoirs on the mollusca of New Zealand, by Prof. Hutton.—On New Zealand crustacea, by C. Chilton.—On the skeleton of *Notornis mantelli*, Py Prof. Parker.—On New Zealand shells and cephalopoda, by T. W. Kirk.—On the Coccidæ of New Zealand, by W. M. Maskell.—On New Zealand crustacea, by G. M. Thomson.—On new Orthoptera and Coleoptera, by W. Colenso.—On the freshwater algæ of New Zealand, by W. Spencer (a very imperfect paper).—On additions to the flora, by T. F. Cheeseman.—On new species of plants from New Zealand forests, by W. Colenso.—On the Alpine flora of New Zealand, by John Buchanan.—On the New Zealand olives, and on recent additions to the flora, by T. Kirk.—On a deposit of moa bones (probably the oldest yet found) near Motanau, North Canterbury, by A. McKay.—Notes on the mineralogy of New Zealand, by S. Herbert Cox.

Berichte über die Verhandlungen der Naturforschenden Gesellschaft zu Freiburg, I.B. Band viii. Heft 1, 1882.—On some actions of coercitive force, by E. Warburg.—Imitation of the phenomena of optically-anomalous crystals by stretched colloids, by F. Klocke.—On the action of unilateral pressure on optically-anomalous crystals of alum, idocrase, and apophyllite, by the same.—Axial images in convergent light in alum, nitrate of lead, pressed gelatine, and quickly-cooled glass, by the same.—On the motion of glaciers, by K. R. Koch and Fr. Klocke (second paper).—On the classification of surfaces according to the displaceability of their geodetic triangles, by H. v. Mangoldt.—On the connection between viscosity and density in fluid, especially gaseous fluid substances, by E. Warburg and L. v. Babs.—On a method of testing micrometer screws, by K. R. Koch.

Schriften der Naturforschenden Gesellschaft in Danzig, vol. v. Heft 3, 1882.—Pagan remains found in the Weichsel-Nogal delta, by Dr. Marshall.—Communications on amber, by O. Helm.—A case of duplication of the allantois and the external genitals, by O. Meyer.—Proceedings of the West Prussian Botanical-Zoological Society; fourth meeting at Elbing in June, 1881.—On the hygienic significance of drinking water and rational principles for its examination and estimation, by M. Barth.—On Cenomanian petrefactions from the diluvium of the environs of Danzig, by J. Kiesow.—Telegraphic determination of longitude between Danzig and Königsberg, by E. Kayser.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 2.—M. Blanchard in the chair.—Reference was made by M. Dumas to the death of Friedrich Wöhler (who was a Foreign Associate).—M. de Candolle presented a work on the origin of cultivated plants. It treats of 247 species; and of all, except three (viz. two species of *Cucurbita* and the kidney bean), it is possible to say whether they are from the old or the new world. Of 49 species cultivated for more than 4000 years, six or seven are extinct or in course of extinction.—Transit of Venus over the sun, by M. Dumas. The last of the eight missions, that to Florida, under Col. Perrier, left Havre on September 30. M. Dumas gives the complete list. The navy figures prominently. There are three members of the Academy, MM. d'Abbadie and Tisserand, and Col. Perrier; also a nephew of Arago. The eight destinations are: Port-au-Prince, Mexico, Martinique, Florida, Santa-Cruz, Chili, Chubnt, and Rio-Negro. Each station will have two equatorials carefully tested. The members have all practised at the Observatory with artificial transits. Most of the missions will use photography. The railway and steamboat companies have given great facilities in transport.—On the shock of imperfectly electric bodies, by M. Resal.—Typographic reproduction of photographs; process of M. Ch. Petit, by M. Marey. Two samples of the process (which is named *similigravure*, but is not described), are given.—Optical communications between Mauritius and Reunion, by Mr. Adams.—The coercitive force of steel rendered permanent by compression, by M. Clémandot. He attributes the effect to the more absolute homogeneity produced by pressure and cooling under pressure. The steel submitted to compression is *soft*, and may be filed, bored, &c.—Researches on the action of the intermolecular ether in the propagation of light, by M. De Klercker. He believes he has, by a purely physical method, established a new theory of the action.—On the treatment of phylloxerised vines with coal tar, *àpropos* of a recent communication of M. Max Cernu, by M. Balbiani.—On the employment of heavy oils of coal in treatment against the winter egg of phylloxera, by M. De Laffitte.—A telegram from Munich (October 2) announced that the experimental transmission of force by an ordinary telegraph wire, between Miesbach and Munich (57 km.), by M. Deprez' method, had fully succeeded. Another telegram (September 26) was received from the Emperor of Brazil about the comet. The presence of sodium and carbon was noted.—Observations of the comets Barnard and Common (1882), at the Lyons Observatory, by M. André.—On a class of uniform functions of two independent variables, by M. Piccard.—Hydrodiapasons, by M. Decharme. One of these is formed of a brass tube of elongated U shape, with a nozzle screwed into the curved part and conducting town water. The upper part of each branch is bent round, so that the free ends are closely opposed. To these ends disks or other pieces may be attached with screws. On passage of the water, a regular vibratory motion occurs, with sound; by attraction if the branch-nozzles have thick edges, by repulsion, if they have thin. The experiment is better if the branches are put in water. The feeling when one touches the instrument is like that of shocks from a weak induction coil.—On the nature of vibratory motions which accompany the propagation of flame in combustible gaseous mixtures, by MM. Mallard and Le Chatelier. They have studied, with the help of photography, the period of accelerated and very irregular velocity (accompanied by sound), which follows a (first) period of slower, silent, and regular propagation, in a tube closed at one end, and having its combustible gaseous contents (bioxide of nitrogen and sulphide of carbon) lit at the other. A vibratory movement is indicated; the amplitude increasing as the last third of the tube's length is neared (where is one of the ventral segments of vibration). A mean pressure of at least 5 atm. is produced for a few ten-thousandths of a second. The mean velocity of propagation is accelerated as the amplitude and rapidity of the vibrations increase.—Action of anhydrous chloride of aluminium on the acetone, by M. Louise.—On the secretory epithelium of the kidney of batrachians, by M. Bouillot.—Cause of the rot of grapes in America, by M. Prillieux. The rot is due to penetration of *Peronospora*, not to *Phoma uvicola*, which is merely developed on the grapes already killed.—M. Daubrée sketched the work of a Committee which has reported to the Minister of Public Works on the means of preventing explosions of fire-damp.—M. Daubrée presented a catalogue of the collection of meteorites of the Museum of Natural History on July 1, 1882, and noted recent acquisitions, &c.

CONTENTS

THURSDAY, OCTOBER 19, 1882

THE BURMAN

The Burman: his Life and Notions. By Shway Yoe, Subject of the Great Queen. (London: Macmillan and Co., 1882.)

THE author of these two lively little volumes tells us that Shway Yoe is the name he is known by in Burma (Shway means "Golden," and is a common Burmese epithet). He himself writes in the character of a Burman, but Englishmen who have lived in the country say that there is no native capable of having written a page of such a book. Accordingly, while respecting the writer's incognito, we must consider him to be an Englishman who does not care to publish his name; but whoever he is, it is plain he knows the land and its language and ways intimately. To Europeans going there, his work will be a guide of practical value, the more so because their difficulties so often arise from misunderstandings which knowledge of native habits would prevent. For example, an Englishman, eager to push forward on his journey on a Saturday, is furious because his servants cannot be got to buy bullocks for the cart till next day. He declares it is dilatoriness or the desire to stay and see some feast, whereas the real reason is that the day is unlucky—"it is a matter of conscience, and was taught to the Burman in a rhyme when he was a little boy at school." On the other hand, the Englishman himself gets into trouble when out shooting by going on regardless of a finger-post which gives notice that a monastery lies near, and that animals must not be killed there. While the lay Burmese are generally rather slack in condemning violations by hunters and fishers of the Buddhist law not to take life, and indeed are not averse to enjoying the results in the shape of curry and strong-smelling fish-paste, yet it would be too much to expect such profanation to be allowed under the very eyes of the holy ascetics. Another way here mentioned in which our English officials both take and give offence, really arises out of an idea belonging to the early philosophy of religion having survived with great tenacity in this corner of the globe. The Burmese have not yet come to our advanced opinion that dreams are mere subjective impressions of the sleeper's mind. The animistic view still prevails that dreaming is the actual experience of the person's life or soul, which they conceive to go forth from his body in butterfly-shape, and flutter about; this leip-bya, as it is called, only going to places its owner has visited before, which accounts for dreams being of known localities. The working-out of this theory as to the causes of disease and death (vol. ii., chap. xi.) is a good specimen of the author's style. It is because of the absence of the butterfly that the Burmese (like other peoples in the same intellectual stage) are unwilling to wake a sleeping man, for his spirit might be wandering far away and not have time to get back, so that its owner would fall ill. Foreigners do not always understand this primitive biology.

"An English assistant commissioner rides unexpectedly into a small townlet in his sub-division and calls for the headman. That worthy is having his afternoon siesta, and the good wife announces this with a composure which almost surprises the young sub-janta walla into swearing. He says, 'Well, then, wake him, and tell him to bring his accounts along to the traveller's bungalow.' Old Mah Gyee shudders at the very thought, and flatly refuses. The Englishman gallops off in a fury at the dreadful impertinence of the people, and Mah Gyee calls together all her gossips to hear of the brutality of the young ayaybaing, who actually wanted her to imperil her good man's life. It needs something more than passing examinations and being a smart report-writer to govern the people well."

This dream-theory seems one of the many points of earlier and cruder religion which the Burmese keep up, notwithstanding their conversion to Buddhism. Thus they still propitiate with offerings and prayers the nats or spirits which they regard as swarming over land and water, in house or forest. That this is the old local religion is proved by its prevalence among indigenous tribes who have not learnt Buddhism, or have not assimilated its teachings so far as the Burmese proper. Thus no low class Talaing would think of eating a morsel without first holding up his platter in the air, and breathing a prayer to the village nat; while at the entrance to a Kachin village may be seen not only the remains of food and drink put out for the spirits, but even axes and choppers for them to fight with, and all this not for the love of these beings, but to give them whatever they want, so that they may let the villagers alone. It is not surprising that the subtle metaphysics of Buddhism should be over the heads of the uneducated in Burma as elsewhere. Thus Buddhist doctrine does not recognise a separate surviving soul after death. Physical individuality ceases at a man's death and dispersion into the elements, but a new personality arises in the being which succeeds him, conditioned by *karma* (Burmese *kan*), the result of the deeds of the whole line of predecessors. European students like Rhys Davids may well admire this speculative attempt to account by a chain of causation for each man's disposition and character, and may notice its foreshadowing of modern evolutionist ideas of inherited characters; but the tillers of the paddy-fields of the Irrawaddy must find much easier the simple physical conception of a dream-soul.

In the more learned Burmese monasteries Buddhist doctrine is studied, and scholars may be found to discuss the distinction between karma and transmigration of souls, or to show that *nirwana* (Burmese *neh'ban*) is not annihilation, as so many Europeans erroneously suppose. The author even claims "that at the present time Buddhism exists in Burma in a form much nearer to that which Shin Gautama taught than is found in any country where the Three Precious Things are held in reverence." Now Burmese Buddhism is doubtless purer than that of the gross and dull Tibetans, but it is setting the disciple above the master to put it thus into competition with the Buddhism of Ceylon, whence the Burmese received the missionaries and had translations of the Pali books. As to the moral rules which even more than philosophic beliefs are vital to Buddhism, their effect doubtless still manifests itself in a mildness and kindliness of life controlling the natural character, which is described as hot-blooded and combative. But the observance of the moral precepts has fallen so much away from the original standard, that we have here an instructive example of religious decay in the sophistry by which they are kept in form while violated in reality. Buddhists who lead the ascetic life are bound to support themselves by carrying round the almsbowl from house to house, not asking for anything, nor going to the doors of the rich rather than the poor, but taking what is given, and eating with loathing so much as is necessary to prevent death. The almsbowl is still the sign of the holy man, and he carries it round, but it is only in the severest monasteries that he really eats the indiscriminate bits of fish and flesh and handfuls of rice and mango. The mess generally goes to the little boy-scholars, and after them to the crows and pariah dogs, while the monks set to on a comfortable hot breakfast in the monastery. With like ingenuity the ascetic will sit with his back to the sun, so that he does not know when it is afternoon, and can take another meal without breaking the law; while some, mindful of the law not to touch money, will wrap their hands in a cloth and then take it. Among the casuistic points which the student of morals finds most curious in theoretical and practical Buddhism is that alluded to already, how in a religion where the taking of life is one of the five great sins, even the monks receive fish and meat in their almsbowls, and every village is pervaded by the smell of nga-pee, which seems to go far beyond that of anchovy sauce, its nearest English correlative. The answer is, that if necessity drives a man to the wicked life of killing animals, he will pay the penalty in ages of misery in future states, but he who eats the meat is no way responsible. Even the fisherman finds his way out of the loose-meshed moral net:—

> "Fishermen are promised terrible punishments in a future life for the number of lives they take, but popular sympathy finds a loophole of escape for them. They do not actually kill the fish. These are merely put out on the bank to dry after their long soaking in the river, and if they are foolish and ill-judged enough to die while undergoing the process, it is their own fault."

The passage of which this is part (vol. i. p. 341) may be recognised as coming from Prof. Adolf Bastian's "Reisen in Birma," which forms the second volume of his "Voelker des Oestlichen Asien." Of this important book, which has not been translated into English, the present author has in several places made use.

It is not only through Buddhism that Hindu influence has acted on Burma; indeed in one way or another, three-fourths of its civilisation seems to have been borrowed from India. This accounts for various popular superstitions, familiar in Europe as belonging to the Aryan nations, re-appearing among this Mongoloid race of South-Eastern Asia. Thus as the ordeal by water has in India the authority of the Code of Manu, it is not surprising that ducking witches is a mode of trial familiar to the Burmese; our officials now prohibit it in British territory, possibly not telling the natives how lately we did it ourselves. Another superstition here noticed, is that a Burmese prizes a child's caul as much as an English sailor does. The one may expect by its means to gain the favour of some great man, while the other carries it to save him from drowning; but these are only particular ways in which the mysterious envelope exerts its general power of giving protection or luck. It would be interesting to learn whether the Burmese have the idea of its being the abode of the child's soul or guardian spirit, which may be the source of the whole group of beliefs. The system of magic, mostly astrology, which stultifies so much of the life of the Burmese, seems almost entirely Hindu, in fact the court astrologers are a caste of Brahmans. One of their chief proceedings is to connect the days of the week in all sorts of ways with men's lives The Hindus learnt the week and its seven planet-named days through the Greek-Roman astrologers, perhaps not much earlier than our ancestors did, but while among us its astrological significance only survives in such folklore rhymes as "Monday's child is fair of face," &c., in Burma it regulates even the children's names. The letters of the alphabet are grouped in connection with the planets and their days, so that for instance a child born on Sunday must have a name beginning with a vowel, as Moung *Ohn* (Mr. Cocoanut), Ma *Eh* (Miss Cold), or Oo *Oh* (Old Pot). Thus people's names not only give the magician information as to their planets, characters, and fates, but they even determine what couples may not marry, for instance, a Friday's daughter must not marry a Monday's son, for their life would be short. Thus, too, their names will direct the doctor how to diet them when sick, as for example the Sunday-born persons whose names are given above would have to avoid food beginning with a vowel, as eggs (*oo*) or cocoa-nuts (*ohn*).

It is not our province to discuss the chapters relating to practical politics, such as the rice-trade, the annexation-question, or even the great shoe-question which weighs so heavily on the local diplomatic mind. But two more subjects may be mentioned as interesting from the anthropological point of view. One is the recognition of dancing as a direct expression of emotion (vol. ii. chap. i.).

> "If a great man wants dancing he hires people to do it for him. If indeed he becomes greatly excited at a boat race, a buffalo fight, or a religious procession on its way through the town to the pagoda, he may tuck up his pasoh tightly round his thighs and caper away till his bare legs tire, but he does so ordinarily with a ludicrously solemn aspect, as if the performance were a part of his official duties, and to be got through with as much stately dignity as the dispensing of justice from the magisterial bench. It is a concession to the excitability of his nature, and he would be very much offended if next day, when he had calmed down to his ordinary composed demeanour, an Englishman were to compliment him on the agility he displayed, or the complexity of his evolutions on the previous day."

The other subject to be referred to is tattooing, which is a fine art in Burma as elsewhere in this part of Asia. A lad does not consider himself a man till he has been tattooed from waist to knees with what looks like a pair of drawers embroidered blue with elephants, apes, and tigers. The operation is so painful that opium is usually taken to deaden the pain. The instrument is a steel point, split to hold the lampblack, this pricker being fitted in a weighted holder two feet long. Besides these figures done for decoration, charm-figures and magic squares are pricked in for love-charms, or to preserve from snake-bite or drowning. It is the more interesting to read these details, as there has for some time been an extraordinary specimen of Burmese tattooing to be seen in England, namely, the "Tattooed Man," who was some while since exhibited at the Westminster Aquarium, and who is an Albanian Suliot named Georgios Konstantinos. Setting aside his mostly fictitious story of having been tattooed as a punishment in Central Asia, the fact is that his decoration with some 400 figures all over his body except the soles of his feet, was evidently done by Burmese tattooers, and is a masterpiece of their unpleasant craft. There is an account of him by Mr. Franks in the *Journal of the Anthropological Institute* for 1872.

E. B. TYLOR

PROF. STRASBURGER'S RECENT RESEARCHES

Ueber den Bau und das Wachsthum der Zellhäute. Von Dr. Ed. Strasburger, Professor an der Universität Bonn. (Jena, 1882.)

THE work before us is another evidence of Prof. Strasburger's untiring industry and minute research. Interesting as all his books have been, this one may be said to surpass its predecessors in this respect, inasmuch as the questions with which it deals are of such fundamental importance in botanical science. The main object of the researches here published is to throw light upon two difficult and much-discussed points, namely, the intimate structure of organised bodies, and the mode of growth of cell-walls and starch-grains. With regard to the researches themselves it need only be said that they appear to have been carried out with Prof. Strasburger's accustomed thoroughness and accuracy, and that they are abundantly illustrated by beautiful drawings. The conclusions deduced from them are so remarkable that a brief *résumé* will not be out of place.

With regard to the intimate structure of organised bodies, Prof. Strasburger entirely dissents from that view which is known to all botanists as Naegeli's micellar hypothesis.[1] This hypothesis was based upon the phenomena of "swelling-up" which are so characteristic of organised bodies, and upon the optical properties which certain of these bodies possess. Prof. Strasburger points out that swelling-up may be as well ascribed to the taking-up of water between the molecules of the body as to its being taken up between Naegeli's micellæ. He shows also in a striking manner that the double refraction of organised bodies, such as cell-walls and starch-grains, depends upon their organisation as a whole, for when once their organisation is destroyed their double refraction is lost, a result which cannot be explained on the micellar theory since the particles of the disintegrated micellæ would, like particles of broken crystals, still retain their double refraction. According to Prof. Strasburger the molecules of an organised body are not aggregated into micellæ which are held together by attraction, but they are linked together, probably by means of multivalent atoms, by chemical affinity in a reticulate manner. Swelling-up is then the expression of the taking-up of water into the meshes of the molecular reticulum, where it is retained by intermolecular capillarity. The more extensible the reticulum, that is, the more mobile the groups of molecules within their position of equilibrium, the greater the amount of swelling-up. The limit is reached when the chemical affinity of the molecules and the force of the intermolecular capillarity are equal; if the latter exceed the former at any moment the result is the destruction of the molecular reticulum, or, in other words, of the organisation. Protoplasm differs from other organised bodies in that the grouping of its molecules is undergoing perpetual change, the result of this molecular activity being the phenomena which we term vital.

The growth in thickness of cell-walls and of starch-grains takes place, according to Prof. Strasburger, by the deposition of successive layers. Here again he is at issue with Naegeli, who believed that the mode of growth was intussusceptive with subsequent differentiation of layers. It is impossible to go into detail with regard to the observations from which his conclusion has been formed; it need only be said that they are very numerous and elaborate, and that they confirm those of Dippel and of Schimper. Prof. Strasburger goes indeed so far as to say that even the surface-growth of cell-walls is not intussusceptive, but is merely due to stretching. It must be admitted that, assuming that all cellulose is derived from proteid, it is difficult to understand how proteid particles can be intercalated into the cell-wall to become subsequently converted into cellulose, but it is equally difficult to imagine that the wall of large cells, such for instance as an internodal cell of *Nitella* or a laticiferous cell of *Euphorbia*, is simply the much-stretched wall of the small cell from which these originated. Surely the amount of solid substance in the wall of such cells as these increases with its increased surface! Here further investigation is doubtless needed.

There is, however, one point of detail which is of such general interest that it deserves some consideration; it is with reference to the mode of formation of the cell-wall and of the thickening-layers. Schmitz some years ago expressed the opinion that the cell-wall is formed by the actual conversion of a layer of the protoplasm, that is, chemically speaking, by the production of a layer of cellulose from a layer of proteid. With this opinion Professor Strasburger entirely agrees, and he supports it by a number of remarkable observations. When a mass of protoplasm is about to clothe itself with a membrane, the peripheral layer becomes densely filled with minute proteid bodies, the microsomata, and this layer then becomes converted into cellulose. The wall of a young wood-cell of *Pinus*, for instance, is clothed internally with a layer of protoplasm filled with microsomata, which are arranged in spiral rows; the microsomata then gradually disappear, and the layer of protoplasm is found to be replaced by a layer of cellulose, which presents spiral striation corresponding to the previously existing rows of microsomata, and which constitutes a thickening layer of the cell-wall. In cells the walls of which become much thickened, the whole of the protoplasm may be gradually used up in this way. Again, the wall of pollen-grains and of spores is formed from a peripheral layer of the protoplasm which contains abundant microsomata. Its subsequent growth, and especially the development of the asperities which it commonly presents, is effected by the surrounding protoplasm which is derived from the disorganised tapetal cells; this is especially well shown in the development of the epispore (perinium) of *Equisetum* and of *Marsilia*. When an intine or endospore is present, it is produced, like the outer coat, from a peripheral layer of the protoplasm of the pollen-grain or spore. Further, the septum which is formed in the division of a cell is

---

[1] See NATURE, vol. xxiii. p. 78.

produced in the same way. The cell-plate, like the peripheral layer of the protoplasm of a young pollen-grain, contains microsomata which disappear, and it is then converted into a plate of cellulose. Finally, the successive layers of a starch-grain are produced by the alteration into starch of layers of proteid-substance derived from the starch-forming corpuscle (amyloplast).

Besides dealing thoroughly with these main points, Prof. Strasburger touches upon others which are also of great importance. He points out that the starch which makes its appearance in the chlorophyll-corpuscles under the influence of light, is derived from the proteid of the corpuscles by dissociation. The formation of this starch is therefore not the immediate product of the synthetic processes going on in the chlorophyll-corpuscles, but only a mediate product. The processes in question produce proteid. Prof. Strasburger is inclined to accept Erlenmeyer's hypothesis, that methyl aldehyd is formed in the chlorophyll-corpuscles from carbonic dioxide and water and to believe that by polymerisation a substance is produced which can combine with the nitrogenous residues of previous dissociations of proteid to reconstitute proteid. He does not agree with the suggestion of Loew and Bokorny that the methyl aldehyd may combine with ammonia and sulphur to form proteid *de novo*.

Lastly, Prof. Strasburger makes an interesting suggestion as to the probable physiological significance of the nucleus. He points out that the nucleus cannot be regarded as regulating cell-division, for instances are known of cell-division taking place without previous nuclear division, and, conversely, of nuclear division taking place without cell-division. He is of opinion that the nucleus plays an important part in the formation of proteid in the cell. This view is founded upon the facts that one or more nuclei have been found to be present in the vast majority of plant-cells, that the nucleus is, as a general rule, the most persistent protoplasmic structure, and that it gives the various proteid reactions in a very marked manner. SYDNEY H. VINES

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Behaviour of Sulphate of Lead in a Secondary Battery

SINCE the meeting of the British Association at Southampton I have made several experiments on the action of sulphate of lead at the negative pole of a decomposition cell, with a view to ascertain, not whether the sulphate was reduced in bulk by the action of the nascent hydrogen, a matter concerning which I had satisfied myself before in the negative, but the less practically important matter whether any *trace* of metallic lead could be obtained upon the negative plate by this action.

I used, therefore, platinum electrodes, immersing them in a paste of sulphate of lead in dilute sulphuric acid And at the suggestion of Prof. McLeod, in order to obtain sulphate pure and in a fine state of subdivision, I precipitated a quantity from dissolved carbonate.

The paste soon settled down, leaving about a quarter of an inch of clear liquid above it, which was decanted off. Small thick platinum plates stood in the paste about 2 inches apart, and were connected with either three or two Lechlanché cells. When three cells were used, the evolution of gas from both plates speedily scooped out a hole round each filled with only turbid liquid, which was kept agitated by the bubbles.

Under these circumstances a distinct darkening of both plates occurred, and after a day or two they showed a distinct though extremely thin coating of percxide and of metallic lead respectively. Prof. McLeod had tried the same kind of experiment, and noticed that the darkening occurred more readily on portions of the plate in contact only with free liquid than on those imbedded in paste.

I therefore re-embedded my plates, and employed only two cells to charge them, so that the bubbles might not have power enough to remove the paste from contact with the plates at all parts; under these circumstances the growth of peroxide of lead at the + plate was abundant, so much so that when the plate was ultimately pulled out, it left a black mass behind it, which had penetrated into the white paste; but the growth of the metallic lead on the – plate was even less perceptible than before, and it was evident that the metallic lead was better deposited from the solution than from the paste. It seemed probable, therefore, that though the sulphate is extremely insoluble in dilute acid, yet that a sufficient trace was dissolved to be acted on by the hydrogen, and that as fast as this was decomposed more was dissolved from the large quantity of solid present, provided the liquid was free to circulate and become replenished.

To test this further, I first made a saturated solution of sulphate of lead in the acid, by shaking and stirring it up with the finely divided precipitate for many hours—though ordinary dilute sulphuric acid is probably perfectly saturated without any such treatment—and then electrolysed the clear solution. No effect is ordinarily perceived under these circumstances, and I could perceive none. Hence the quantity dissolved at one time must be something infinitesimal; and it is able to give no appreciable deposit, unless fresh solid is present to replenish it.

Next I took a vessel full of the sulphate paste, but with a third of an inch clear liquid standing above it; and into this clear liquid I dipped the platinum plates, barely letting them touch the pasty mass below. In this position they remained several days connected to two Leclanchés, and the result was a distinct blackening of the – plate with a deposit of metallic lead from the solution; but the + plate scarcely seemed to receive any deposit of peroxide except along its bottom edge, which probably just touched the paste, and which showed a narrow line of deep puce colour. The observation that the – plate received its deposit more easily from the free solution than from the paste, had been previously made by Prof. McLeod. But to get the deposit most quickly, it is best to immerse the plates in the paste, and to cause sufficient gas to be evolved to keep them free from actual contact with it; while at the same time the solution surrounding them is so near a large surface of paste, that it can be very rapidly replenished.

On neutralising the acid with ammonia, so that ammoniacal salts and common salt might be present, in which sulphate of lead is known to be somewhat soluble, the deposit of metallic lead went on with far greater rapidity.

I have subsequently repeated the experiments with a paste of ordinary sulphate of lead, and the results appear to be quite the same. A week's deposit could be dissolved off the negative platinum plate with a single drop of nitric acid, and could only be made to show a faint precipitate when sulphuric acid was added to this solution in a watch-glass.

Moreover, unless the plate were rinsed on extracting it from the paste, the small amount of sulphuric acid clinging to it was sufficient to so whiten the deposit in the course of a night as to make it seem almost as if it had disappeared.

The matter is rather a small one to write so much about, but the behaviour of sulphate of lead in secondary batteries is really of considerable importance, and is at the bottom of a great many of the difficulties which one meets with in practical operations with secondary lead cells.

Moreover, it is only due to Dr. Gladstone that I should say how far I have been able to obtain his results; and he will perceive that if all he asserts is that platinum electrodes do show a nearly infinitesimal tarnish of metallic lead (as I understood him to say at Southampton), then my experience agrees with his. But I think that this is merely due to the partial solubility of the sulphate; and I never find that the reduction is able to spread through the paste in the slightest degree, in such a way as to have any practical bearing on the behaviour of a secondary battery. OLIVER J. LODGE

University College, Liverpool.

On the Conservation of Solar Radiation

IT appears to me a difficulty arises with regard to Dr. Siemens' theory when we consider the original condition of the earth and of the other planets. What, in fact, has become of the great amount of energy which was present in the form of heat in those bodies?

Just as in the case of the sun, the rotation of the earth would produce a continuous cycle current, the decrease of rotatory energy being perhaps counterbalanced by shrinkage, the radiant heat would become transformed into the potential energy of dissociation, and this energy again would be given back to the earth in the form of heat in another part of the circuit where the elements recombine. Now it is quite impossible that the whole of the heat radiated should be used in this way, for after a lapse of years we should find a considerable diminution of potential, or (perhaps) rotatory energy, and we therefore should be forced to the conclusion that the earth became continually hotter. Hence some of the radiant heat escaped must have escaped into space, never to return.

Is it then a feasible solution that more heat is radiating from the sun than is necessary for the dissociation of the elements? If so, then at least we should have a satisfactory explanation of its slowly-diminishing activity. G. B. S.

THE writer of this letter is right in concluding that in accordance with my hypothesis the earth also must throw out a stream of matter equatorially into space; and if your correspondent will refer to my article in the *Nineteenth Century* of April last, he will find that at p. 522 I speak of such a terrestrial outflow, with which I connect the phenomena of Aurora Borealis. If at any period of the world's history the rotatory velocity of the earth has been much greater than it is now, and its surface-temperature sufficiently high to cause ignition of combustible gases, it may be reasonably supposed that it had the power of recuperating its heat of radiation. The amount of heat so recuperated would, under all circumstances, be less than that received back by combustion, and the result of gradual diminution of temperature would be that on a certain day the temperature must have fallen below the point of ignition, from which day forward no further recuperation of heat could be expected. The process of cooling would then proceed at a very rapid ratio, until the surface-temperature had reached another point of comparative constancy, at which the radiation into space was balanced by the heat received by solar radiation, and which is our present condition. C. W. SIEMENS

12, Queen Anne's Gate, S.W., October 16

The Great Comet and Schmidt's Comet

THERE can be no doubt of the elongation of the nucleus of the Great Comet in the direction of the axis of the tail, in which direction it is three times as long as in a direction at right angles thereto.

The place of the comet this morning, at 6h. 0m. G.M.T., was

R.A. = 10h. 18m. 53 ± 5 secs.
P.D. = 103° 31′ 35″ ± 10″.

A neighbouring object was carefully observed, through haze, as a star of reference; its place was

R.A = 10h. 18m. 53s.
P.D. = 102° 30′ 0″

On consulting the Catalogue, it appears there is no star in this place. The object observed was probably Schmidt's Comet, discovered on the 8th of this month, but not since heard of here.

Unfortunately the above are absolute, not differential measures, but they have been corrected by measures of λ Draconis, also observed as a star of reference; its place is

R.A. = 10h. 4m. 46s.
P.D. = 101° 46′ 27″.

WENTWORTH ERCK

Sherrington House, Bray, October 16

[The nearest bright star to Mr. Erck's place is L. 20158, 6·7 mag. in Gould; R.A. for 1882, 10h. 17m. 32s., N.P.D. 102° 47′. λ Draconis is evidently a slip of the pen for λ Hydræ.—ED.]

The B.A. Unit

I WISH to call the attention of readers of NATURE who are interested in the experiments which have recently been made for the determination of the B.A. unit of resistance, to a paper by F. Kohlrausch, read before the Academy of Sciences at Göttingen, September 6, 1882, "On the Measurement by Electrical means of the mean Area of the windings of a Coil." Prof. Kohlrausch has applied his method to redetermine the mean area of the coils of the earth inductor used by him in his experiments on the value of the B.A. unit in 1874. He finds the area of this coil to be 387,200 sq. cm.; the value used in 1874, calculated from the geometrical measurements of Weber in 1853, was 392,800 sq. cm. In consequence the value of the B.A. unit as determined from his experiments requires alteration, and, making the necessary corrections, Prof. Kohlrausch obtains

$$1 \text{ B.A. unit} = \cdot 990 \times 10^9 \frac{\text{cm.}}{\text{sec.}},$$

agreeing much more nearly with the values found by Rowland, Rayleigh and Schuster, and myself. R. T. GLAZEBROOK

Trinity College, Cambridge, October 13

The African Rivers and Meteorology

THINKING that the following extract from a letter written from the Niger Delta may be of interest to your readers, I beg leave to offer it for insertion.

"As yet there has been little water in the Niger, the rise up to the present (August 29) has not been over 3 feet in the lower river, and they say no rise has taken place in the upper river as yet. The upper river commences at Locayo, or where the Benue or Chadda joins the Niger, and continues thence on to Timbuctoo. So far as I can foresee, there will be a famine in the Niger Valley this year, as there has been a complete failure of the first crop from drought, and there has been no chance of putting in the second crop for the same reason."

The regimen of the waters of such great rivers as the Nile, the Niger, and the Congo, both as to quantity and periods of rise and fall, must be closely related to the meteorological conditions of the highlands of Africa, so little known to us, so extensive, and as yet so inaccessible for observation. May it not, therefore, be assumed that the comparative and continuous study and observation of those rivers as regards their volumes and periods of rise and fall, would be likely to furnish most valuable data for the prediction or forecast of weather in Europe. Thinking so, I have suggested to my correspondent the advisability of keeping a systematic record of the rise of the river Niger, and, if possible, of the temperature and other conditions of the water, with a view to their utilisation for meteorological purposes, and from this point of view I have thought that the above communication may present some interest. J. P. O'REILLY

Royal College of Science for Ireland, Dublin, October 13

A "Natural" Experiment in Complementary Colours

YESTERDAY evening I was reading Goethe's account of his visit to the falls of Schaffhausen ("Journey to Switzerland in 1797"). After mentioning that the morning was a misty one, and describing the general effect of the cataract, he adds: "Wenn die strömenden Stellen grün aussehen, so erscheint der nächste Gischt leise purpur gefärbt." I had certainly never heard of this phenomenon before, but it naturally occurred to me that it was probably an effect of complementary colours. Less than two hours afterwards I opened NATURE for the week, and found precisely the same phenomenon, with the same explanation as given by Mr. C. T. Whitmell. The point is interesting, as giving testimony to Goethe's close and accurate observation of colour phenomena; while the coincidence involved seems also to be worth recording. WALTER R. BROWNE

October 13

Ventilation of Small Houses

I HAVE been much interested in the reports of the Sanitary Institute. May I call attention to the fact that the majority of the smaller houses in our large towns have no means of ventilation except through the rooms. There are no ventilators or staircase windows, and the back house door opens into the kitchen. In a three-storied house the staircase is lit by the fanlight over the front door and a skylight in the roof, neither of which opens; this arrangement gives little enough light and no air. Can it be healthy? Ought it to be? It is at least most disagreeable. A. H.

October 15

ON THE PROPOSED FORTH BRIDGE

AN interesting account of the plan of the railway bridge for crossing the Forth at Queensferry, as designed by our distinguished engineer, Mr. Fowler, with the association of Mr. Baker, was given by Mr. Baker to the British Association at their late meeting at Southampton. Supported as it was, to the advantage of those present, by the exhibition of the model of the proposed bridge, it must have given extensive information on the character of the structure. Yet it seems to me that, amidst many valuable particulars, on the strength of materials, their mode of application in this instance, and similar important subjects—it would hardly impress sufficiently, upon the minds of hearers or readers, the vastness of the scheme, the novelty of its arrangements, and the dangers (yet untried) to which, conjecturally, it may be subject. I have thought therefore that I might, without impropriety, offer to the editor of NATURE some remarks on points which after careful consideration have suggested themselves to me. For some particulars I am indebted to the courtesy of Mr. Fowler himself, and I greatly value this kindness.

It is known that at Queensferry the separation of the river-banks, or rather that of the piers next to the banks, at the elevation required for the railway, approaches to a mile. This space is divided by three piers (for which there are excellent foundations on rock and hard clay) into four parts, but only the two middle parts concern us now. They are exactly similar, and are treated in exactly the same way; and subsequent allusions, referring ostensibly to one, are to be considered as applicable to both. Each of the three piers is an iron frame, 350 feet high, the central pier 270 feet wide (in the direction of length of the bridge), and each of the others 150 feet. These lofty frames are braced, each upper angle on one side to lower angle on the other side, with no other diagonal bracing, but with a simple tie at mid-height. The lengths of the diagonal bracing are respectively about 430 and 360 feet. The water-spaces between two piers are each about 1700 feet; and the engineering question now is, how this space of 1700 feet (roughly one-third of a mile) is to be bridged for the passage of a railway.

The plan proposed is, to attach to each side of each frame (that is, to each side which will face a traveller entering upon the bridge) a framed cantilever or bracket about 675 feet long (that is, exceeding in length an English furlong by 15 feet), attached at top and bottom to the iron frame above mentioned, but having no other support in its entire length of 675 feet. To give the reader a practical idea of the length of this bracket, I remark that the length of St. Paul's Cathedral, outside to outside, is exactly 500 feet; and thus this bracket, which is to project over the water without any support whatever, is longer than the Cathedral by 175 feet. This in itself is enough to excite some fear, supposing the bracket to support merely its own weight. But further, the bracket bears also the very considerable weight of the roadway and rails. It is also heavily loaded on its point. The two opposing brackets from the two iron frames cover 1350 feet, but the whole space to be covered is 1700 feet, leaving 350 feet yet to be supplied for the support of the railway. To furnish this, a lattice-girder carrying a railway is provided, rather more than 350 feet long, whose extremities rest upon the tips of the two brackets.

This statement is enough, I think, to justify great alarm. No specimen, I believe, exists of any cantilever protruding to a length comparable, even in a low degree, to the enormous brackets proposed here. The only structures of this class, in ordinary mechanics, known to me, are the swing-bridges for crossing dock-entrances, and the like, and these are absolutely petty in the present comparison.

I now advert to the weights of the principal portions of the bridge, and the strains which they will create. I understand that the weight of the two parallel braced sides of one bracket is about 3360 tons, to which is to be added the weight of roadway and rails for 675 feet, on which I have no information. I proceed to inquire what strains, in the nature of horizontal pull at the top of the pier and horizontal push at the bottom of the pier, will be caused by this weight. If the weight were evenly dispersed over the triangular bracket, its centre of gravity would be distant from the pier by one-third of the distance of the point from the pier. But as no vertical bar near the pier is included in the weights above, I must take a larger factor, say $\frac{2}{5}$. The vertical weight being 3360 tons, acting at a distance from the pier of $\frac{2}{5} \times 675$ feet, and the separation of the points of connection with the pier being 350 feet, it is easily seen that the horizontal pull at the top and push at the bottom are each about 2600 tons. The inclined tension along the great upper bar of the cantilever and the inclined thrust along the great lower bar of the cantilever are therefore each about 2670 tons. The extremities of the great upper bar and the great lower bar being connected at the point of the bracket, and (for a moment) no other weight being supposed to act, there is no tension or thrust at that point, and therefore the tension and the thrust increase gradually, according to the attachment of their loads, from nothing at the point of the bracket to 2670 tons at connection with the pier.

But the point of the bracket is permanently loaded with half the weight of the intermediate 350-feet railway, or 363 tons, and occasionally loaded with the whole weight of a railway train, say for a passenger train 150 tons (a mineral train would be heavier). The vertical weight of 513 tons thus introduced would be met by a tension of 1004 tons through the whole length of the great upper bar, and a thrust of 1004 tons through the whole length of the great lower bar. Thus we have—

For the great upper bar, a tension increasing from 1004 tons near its point, to 3674 tons near the pier.

For the great lower bar, a thrust increasing from 1004 tons near its point, to 3674 tons near the pier.

The second of these statements particularly requires attention.

Mechanical students and professional engineers are accustomed to estimate by numerical measure the magnitude of a horizontal or nearly horizontal thrust, but persons in ordinary life scarcely attach a clear meaning to such a phrase. I am therefore compelled to make a somewhat violent explanatory supposition, with the hope that it may convey a practical impression as to the meaning of the statements just given.

The great lower bar is in fact a nearly flat frame, braced from side to side, about 120 feet wide at the bottom, and about 40 feet wide at the top, and 690 feet long. Suppose this structure to be planted vertically, say in St. Paul's Churchyard, without any bars, chains, or any thing else, below its vertex, to prevent motion edgewise, but with bracing (which, under ordinary circumstances, would suffice, but which will be the subject of further remark) to prevent its moving flatwise. Its top would be 310 feet higher than the top of the cross of St. Paul's Cathedral. Suppose a weight of 1000 tons to be placed on its very top, and additional weights (if necessary) to be placed at its sides, till the whole weight pressing the ground is 3600 tons. In this state its condition is exactly that of the great lower bar, as regards the crushing and distorting tendency of the weights (although the upper weight itself ought to be considered as partially protected from lateral movement by the great upper bar). With this enormous load at this stupendous height, would the citizens of London in the Churchyard below feel themselves in perfect security? I think not; and I claim the same privilege of entertaining the sense of insecurity for the proposed Forth Bridge.

The danger arising from the endwise action of so large a force on so long a bar or frame, is produced by the curvature technically called "buckling," and there appears to be fear of its occurrence in various parts of the bracket, and in some parts sequentially, that is to say, that a buckling of a minor order might lead to a buckling of a more important order. Thus, proceeding from the pier, the first support of the great lower bar is by a suspension-rod from the great upper bar; to which, as regards merely the suspension-rod, there can be no objection. But the upper attachment of this suspension-rod is supported by a thrust-rod about 340 feet long. Can this rod be considered safe against buckling? In the total absence of experiment or explanation, I may be permitted to express a doubt of safety. And if that rod fail. the corresponding part of the great lower bar will sink, it will buckle under its enormous end-thrust, and the bridge will be ruined. The second support of the great lower bar depends, in like manner, on a thrust-rod whose length is 240 feet; considerations of the same kind apply to it, though probably in a minor degree.

Experienced engineers must have known instances in which buildings have failed from want of consideration of buckling. The following occurred within my knowledge. When the Brunswick Theatre was built, the construction of its trussed iron roof was greatly extolled, and Mr. Whewell and myself, then residing at Cambridge, and proposing to visit London about the same time, had arranged to inspect the truss. But before we reached London it was ruined. There was no adequate bracing of the principal rafters in the plane of the roof; the suspension of a very slight weight on the great tie caused the rafters to buckle sideways, and the roof fell, destroying the building.

I am not aware whether a theory of buckling finds place in any of the books which treat of engineering in a somewhat mathematical form. But there ought to be such. It can be formed with no difficulty and little trouble, giving such a form of result, that all that will be required in any case, to determine the end-pressure which can safely be applied to the end of a bar, will be expressed in terms of the length of the bar, and the curvature caused by a tranversal strain (determined by simple experiment). This theorem ought to be applied in every instance.

I need scarcely to remark that every construction is liable to chance-errors of unforeseen character, and I think that the proposed construction, which depends for its safety entirely on the maintenance of the thrust-principle in perfection, is more liable than any other to danger from these causes. A rivet-head may slip, or a screw may strip, and all may be imperilled. Robert Stephenson, when building the Menai Bridge, used every caution that an active mind could invent: in particular he provided that the masonry for final support of the tubes should be raised as quickly as possible to take the bearing of the tubes at every moment. Yet an accident, though a small one, did happen. The ends of the tubes were raised by the power of hydraulic presses; the cylinder of one of these presses burst, and the end of the tube fell three or four inches. This minute fall, in the judgment of the attendant engineers, gave a strain to the tube such as it never sustained before or since. (This accident came first to my knowledge in a singular way. With the assistance of my friends, Capt. Tupman, R.M.A., and James Carpenter, Esq., and before having heard of the accident, I made experiments on the state of permanent magnetism of the great iron tubes. One of these showed an anomaly, somewhat similar to that of iron heavily struck. On my mentioning this to Mr. Edwin Clark and others, the phenomenon was at once referred to the accidental shock which I have described.)

Much has been said on the action of the wind, and on the difference of that action upon a suspended bridge, and upon a girder bridge. In regard (first) to the amount of pressure, I refer to a former letter of mine, correctly cited in the evidence before the Committee on the fall of the Tay Bridge, in which I state that the maximum pressure may be more than 40 lbs. on the square foot (I should say more than 50 lbs. for Scotland), but that this action is so limited, both in time and in local extent [and is, I add, so continually varying in direction], that the average of direct pressure probably would not exceed 10 lbs. on the square foot. In regard (secondly) to the difference of wind-action in the two systems of construction;—the immediate effect of the wind appears to me to be a shock, of limited extent, which is much less likely to be injurious on a comparatively flexible frame suspended from above, than on a jointed frame where every joint must be tight, and where ruin will follow disturbance. In the proposed Forth Bridge, however, there is risk of danger of the most serious kind, which may perhaps surpass all the other dangers. It arises from the horizontal action of the wind on the great projecting brackets, and its tendency to wrench them laterally from their attachments. The ruinous force depends, not simply on the magnitude of the wind's pressure, but also on its leverage; as measured by the proportion of the height of the Tay Bridge or the length of the bracket of the Forth Bridge, to the separation (in each case) of their horizontal attachments to the solid piers. This leverage is considerably greater in the instance of the proposed Forth Bridge than it was in that of the unfortunate Tay Bridge; and we may reasonably expect the destruction of the Forth Bridge in a lighter gale than that which destroyed the Tay Bridge.

I may now collect the heads of my remarks on the proposed Forth Bridge:—

I. The proposed construction is, as applied to railway bridges, entirely novel.

II. The magnitude of its parts is enormous.

III. These has been no succession of instances of the construction, with rising degrees of magnitude, which might furnish experimental knowledge of some of the risks of construction.

IV. The safety of the bridge depends entirely on a system of end-thrusts upon very long rods; a system which appears generally objectionable, but particularly so when the length of the rods is very great.

V. No reference is made to theory applied to the buckling of rods under end-thrusts.

VI. The liability to ruinous disturbance by the lateral power of the wind acting with the leverage of the long brackets appears to be alarmingly great.

My own impression is, that the proposed construction is not a safe one, and I should be happy to hear that it is withdrawn.

I refer unhesitatingly to "the Suspension Bridge" as the construction which I should recommend. On this system generally I remark: (1) that I am incredulous as to the oscillation of 8 feet in extent, or any sensible part of it; (2) that if the railway is slightly arched upwards to the degree corresponding to depression caused by an average train, such a train will run on a horizontal plane; (3) that a stiffening lattice may be used with very good effect against vertical oscillations from all causes.

The considerable height of the piers, and the great length of the suspension-chains, are matters to be viewed carefully.

To reduce them as far as possible, I would suggest for examination the following proposals:—

1. Suppose the stone or iron piers to be much lower than in the plans hitherto proposed, and suppose that the top of a pier carries a bracket on each side, so that the great suspending chain passes over the points of the brackets, and its suspending action begins at those points. The bracket frame may be horizontal where it passes the top of the pier; or it may be raised in a horn on each side, and thus adapted to a smaller height of pier. By this construction, with brackets 150 feet long (a trifle compared with those of the proposed cantilevers), the piers may without difficulty be shortened 200 feet, and the acting-length of suspending chain may be reduced 150 feet at each end, or 300 feet over each water-channel. This would leave much liberty in regard to the curvature of the chain.

2. It is very desirable, if possible, to reduce the specific weight of the chains per yard, corresponding to a specified suspension strain. This has been attempted on the Continent by the use of wire, and it has been highly praised for its combination of lightness and strength. The longest carriage-bridge that I have passed (that of Freyburg, 890 feet span) is a wire bridge. I have also crossed the Rhone at Montelimart by wire arches of considerable span. I know not whether this construction has been tried in England. G. B. AIRY

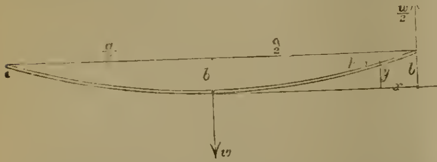
The White House, Greenwich, September 26, 1882

APPENDIX

Having adverted above to the measurement of the endwise or "buckling" force upon a bar, I will here give a theory, by application of which the admissible amount of end-pressure in any case may be ascertained.

The curvature of any point of a bar depends upon the action of two causes. The first cause is the external force, whose angular momentum or effect to bend the bar at any point under consideration is proportional to the product of the force (expressed in multiples of a definite unit—as the pound avoirdupois, or the ton, &c.) by the distance of its line of action from the point under consideration (expressed in multiples of the inch, or the foot, &c.). The second cause is the internal elastic force of the bar produced by curvature, whose tendency is to oppose the bending action of the external force; I shall assume the magnitude of this force to be proportional to the curvature, or inversely proportional to the radius of curvature, at the point under consideration, its coefficient being for the present expressed only as a symbol. The effects of these two causes balance in a quiescent position of the bar, and they must therefore be made algebraically equal.

The course of investigation will now be as follows:—First, I shall give the equation between force and curvature when a bar is bent by a transversal force, acting at the middle of its length. Second, I shall give the similar equation when a bar, at least slightly bent, is exposed to an end-wise force. {The condition "slightly bent" is necessary to exclude the absurdity of a very heavy weight supported end-ways by a very thin wire.} In both cases the results will contain the symbolical coefficient to which I have lately alluded. From the first investigation I shall deduce the value of that co-efficient. I shall substitute it in the result of the second investigation; and finally, shall obtain a most convenient expression for the largest admissible force acting endwise on the bar.



(First). Theory of a bar supported at its ends and bent horizontally by a force applied to the middle of its length. The symbols are sufficiently explained in the diagram. It is indifferent, practically, whether the support of either end of the bar against the force w be a pin (as on the left side), or a force $\frac{w}{2}$ (as on the right side); the latter is the more intelligible. We shall limit our attention to the right-hand half, as the algebraic expressions can be continuous only for the space between two points of application of forces.

Then the angular momentum round the point p produced by the force $\frac{w}{2}$ is $\frac{w}{2} \times x$, tending to throw the point of the bar upwards.

The angular momentum in the opposite direction, produced by the elasticity at p, is proportional to $\frac{1}{\text{radius of curvature at } p}$, or (if the flexure is not very large) to $\frac{d^2y}{dx^2}$; and may be called $C.\frac{d^2y}{dx^2}$, C being the coefficient to which allusion is made above.

Therefore $C.\frac{d^2y}{dx^2}$ must $= \frac{w}{2} \times x$, or $\frac{d^2y}{dx^2} = \frac{w}{2C} \times x$.

Integrating, $\frac{dy}{dx} = \frac{w}{4C} \times x^2 +$ constant. To determine the constant, we remark that, when $x = \frac{a}{2}$ the curve is parallel to the line a, or $\frac{dy}{dx}$ is 0; and therefore $\frac{w}{4C} \times \frac{a^2}{4}$ + constant = 0, or constant $= -\frac{w}{4C} \times \frac{a^2}{4}$; and the complete value of $\frac{dy}{dx} = \frac{w}{4C} \times \left(x^2 - \frac{a^2}{4}\right)$. Integrating again, $y = \frac{w}{4C} \times \left(\frac{x^3}{3} - \frac{a^2x}{4}\right) +$ new constant. When $x = \frac{a}{2}$, y must $= 0$; this gives new constant $= +\frac{a^3}{12}$; and the complete value of $y = \frac{w}{4C} \times \left(\frac{x^3}{3} - \frac{a^2x}{4} + \frac{a^3}{12}\right)$. This is to equal b when $x = 0$, or $\frac{w}{4C} \times \frac{a^3}{12} = b$; from which we obtain $C = \frac{a^3 . w}{48 . b}$.

(Second). Theory of the same bar, at least slightly curved, in a vertical position; its lower end supported on the ground, &c., and its upper end loaded with a weight W.

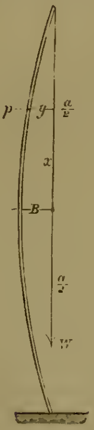
It will be convenient here to take the centre of length of the vertical line for origin of x. As no force or fixation occurs between the two ends of the bar, the same theory will apply throughout.

Here the angular momentum of the weight W on the point p, tending to bend the top to the right, is $W \times y$. The angular momentum produced by the curvature at p, tending to throw the top to the left, is $-C\frac{d^2y}{dx^2}$. {It may be convenient to remember that $\frac{d^2y}{dx^2}$ is here a negative quantity}. To make these balance we have

$$Wy = -C.\frac{d^2y}{dx^2}, \text{ or } \frac{d^2y}{dx^2} + \frac{W}{C}y = 0.$$

The solution of this equation is $y = E . \sin\left(x\sqrt{\frac{W}{C}}\right) + F . \cos\left(x\sqrt{\frac{W}{C}}\right)$: where E and F must be determined to suit the peculiarities of the case. Now, neglecting the weight of the bar (which may usually be done), the curve will be symmetrical above and below; and therefore the value of y will be the same for $x = +e$ and for $x = -e$; e being any number between $-\frac{a}{2}$ and $+\frac{a}{2}$. This cannot hold for $\sin\left(x\sqrt{\frac{W}{C}}\right)$, and therefore we must consider $E = 0$. The solution therefore is restricted to $F.\cos\left(x\sqrt{\frac{W}{C}}\right)$. At the centre of the bar, where $x = 0$, this must $= B$. Therefore the solution is $y = B.\cos\left(x\sqrt{\frac{W}{C}}\right)$.

Now here we have a very remarkable circumstance. It will be remembered that in the first investigation we arrived at a relation between w, the weight, and b, the greatest ordinate of the curve. But here we find no relation whatever; and we come to this conclusion, that for the state of equilibrium fundamentally assumed, the degree of bulge of the bar is immaterial. And this agrees with plain reasoning: by varying the bulge of the bar, we vary in equal proportions, (1) the elasticity which depends on that bulge and on the general curvature, and (2) the distance of the line of action of W from each point p, and its consequent angular momentum; and therefore, if they are equal for one degree of bulge, they will be equal for every degree of bulge. The value of B, therefore is absolutely indeterminate.



But we do obtain one most important conclusion. When $x = \pm\frac{a}{2}$, y must $= 0$. And since, in the product $B.\cos\left(\frac{a}{2}\sqrt{\frac{W}{C}}\right)$, we are not permitted to make B necessarily $= 0$, we must make $\cos\left(\frac{a}{2}\sqrt{\frac{W}{C}}\right) = 0$ The simplest form of effecting this is by making $\frac{a}{2}\sqrt{\frac{W}{C}} = \frac{\pi}{2}$, or $W = C.\frac{\pi^2}{a^2}$. Substituting for C the value $\frac{a^3 . w}{48 . b}$, which was found from the first investigation.

$$W = \frac{\pi^2}{48}.\frac{a}{b}.w = 0{\cdot}206 . \frac{a}{b}.w;$$

and this defines the limiting value of the weight under which the curved bar can rest. If the weight be diminished, the curved bar will expand and lift it; if the weight be increased, that increased weight will crush down the curve.

It is important to observe that the first and second investigations apply to the same bar. And thus, in order to ascertain the limiting buckling force, we need only to ascertain by experiment on the same bar the amount of bend produced by any convenient transversal force.

In some cases, instead of making the first measure by application of the weight w to act horizontally on the middle of the bar, it may be more convenient to make a measure of the vertical flexure of the bar (supported at its two ends in a free horizontal position), produced by its own weight. The following will be the corresponding theory.

(Third). Use the diagram of the first investigation, but substitute c for b, and put Z for the whole weight of the bar: and estimate the angular momentum round the point p. The reaction upwards of the force $\frac{Z}{2}$ at the pin produces $\frac{Z}{2} \times x$. The action downwards of the weight of bar included between the pin and the point p, which is $\frac{Zx}{a}$, will produce $\frac{Zx}{a} \times \frac{x}{2}$ or $\frac{Zx^2}{2a}$. The combination of these produces the angular momentum $Z\left(\frac{x}{2} - \frac{x^2}{2a}\right)$ upwards. The elastic force produces $C \times \frac{d^2y}{dx^2}$ downwards, where C has the same value as in the first and second investigations. Making these equal, $C.\frac{d^2y}{dx^2} = \frac{Z}{2a}(ax - x^2)$. The first integration gives $C.\frac{dy}{dx} = \frac{Z}{a}\left(\frac{ax^2}{4} - \frac{x^3}{6}\right) +$ constant. At the middle of the bar, where $x = \frac{a}{2}$, $\frac{dy}{dx}$ must $= 0$; the constant therefore equals $-\frac{Z}{a}\left(\frac{a^3}{16} - \frac{a^3}{48}\right)$; and $C.\frac{dy}{dx} = \frac{Z}{a}\left(\frac{ax^2}{4} - \frac{x^3}{6} - \frac{a^3}{24}\right)$.

Integrating again, $Cy = \frac{Z}{a}\left(\frac{ax^3}{12} - \frac{x^4}{24} - \frac{a^3x}{24}\right) +$ new constant. This is to be 0 when $x = \frac{a}{2}$; the constant is found to be $+\frac{Z}{a}.a^4.\frac{5}{384}$. For the value when $x = 0$, and consequently $y = c$, we have $C.c = \frac{5a^3.Z}{384}$, or $C = \frac{5a^3.Z}{384.c}$. Inserting this value of C in the expression found in the second investigation,

$$W = \frac{\pi^2}{a^2}.\frac{5a^3.Z}{384.c} = \frac{5\pi^2}{384}.\frac{a}{c}.Z = 0{\cdot}128\frac{a}{c}Z,$$

where (as before) W is the limit of weight acting endwise on the bar, which the bar can bear without buckling.

If we wish roughly to introduce the consideration of the bar's weight, it will be sufficient to remark that at the lower part of the bar the whole weight of the bar is acting in conjunction with the weight W; and therefore, when we have computed the force (as above) we ought to deduct from that result the weight of the bar, and the residual will be the force which is permissible for action on the top of the bar.

G. B. A.

THE LATE DR. VAN MONCKHOVEN

IN Dr. Désiré Charles Van Monckhoven the scientific world has lost an able coadjutor, and his death is to be the more regretted in that he was taken from his many friends when almost in the prime of life. Van Monckhoven was born on September 25, 1834, and on September 25 of this year he died, having thus only traversed forty-eight years of the threescore-and-ten years to which there seemed every human probability he might reach. At an early age he turned his attention to scientific pursuits, and commenced his career as a chemist, the training for which so eminently fitted him for the active part he took for the last twenty-five years in matters relating to photography. When scarcely of age he wrote his "Traité Générale de Photographie," a new edition of which was called for almost year by year, its popularity being nearly unprecedented. Usually sound in his ideas, we may take it that much of the teaching of photo-chemistry has been propagated through the instrumentality of that work. Not only was Van Monckhoven an ardent experimentalist in the domain of chemical physics, but he also entered into all optical questions bearing on photography with a zeal which those alone who had the pleasure of his acquaintance can estimate. The Monckhoven solar enlarging apparatus is a standing record of his great ability in this department of science. At a very early period of his career he applied the spectroscope to record the effects of light on different inorganic and organic bodies, and his photographic researches on the spectra of gases occupied no inconsiderable portion of his time; his very latest published work, presented recently to the Académie des Sciences, being on the effect of temperature and pressure on hydrogen. Whilst Science, for herself, had charms for Van Monckhoven, yet he was able to put to commercial use much of the knowledge which he had acquired. For instance, he entered with enthusiasm into the mysteries of carbon printing, and established a factory for the production of the necessary tissue. Indeed the Monckhoven's tissue is the only one which enters into any sort of competition with that manufactured by the Autotype Company. Again to perfect the preparation of the latest photographic novelty—gelatine plates—he rushed into researches with all the ardour of an experimentalist, and having more or less mastered its intricacy, he established a manufactory for their commercial issue, and probably the Monckhoven plates are better known on the Continent than any other. Van Monckhoven, besides being the author of the treatise on photography, contributed many memoirs to various periodicals, amongst which we may name *La Lumière*, *Le Bulletin Belge*, and *La Revue des deux Mondes*. His style was vigorous, and everything he had to say was written with a terseness which many a busy scientific man may envy. In reviewing Van Monckhoven's life we cannot point to any great discovery or to any startling inventions he made, but he was one of those men who are so useful to science, giving, as it were, the decorations to the more solid building. We are sure that though there may be greater names, there is scarcely one which is more universally known than his, and whose loss will be more universally felt. There are not many who can claim to be distinguished as an astronomer, a chemist, an optician, and photo-chemist, Van Monckhoven could make good his claim to such distinction, and withal to be a busy man in the world of commerce.

Within a short time of his death he was engaged in an important research on the influence of pressure and temperature on the spectra of gases, in which he had introduced quite a new method of attack, and one which promised to be of great value.

THE CHEMISTRY OF THE PLANTÉ AND FAURE ACCUMULATORS

PART IV.—*The Function of Sulphate of Lead*

IN our previous communications on the chemistry of the lead and peroxide batteries we have frequently remarked on the formation of lead sulphate and its importance in the history of a cell.

In Part I. (NATURE, vol. xxv. p. 221) we showed that the local action that takes place at first energetically between the metallic lead and the peroxide is gradually diminished by the formation of sulphate of lead.

In Part II. (vol. xxv. p. 461) we stated that in the original formation of a Faure cell sulphate of lead is oxidated on the one plate and reduced on the other. We also described an experiment in which two platinum plates were covered with lead-sulphate, immersed in dilute sulphuric acid, and placed in the circuit of a galvanic current; the result being that "the white sulphate was decomposed to a large extent on each plate, the positive being covered with deep chocolate-coloured peroxide, the negative with grey spongy lead."

In Part III. (vol. xxvi. p. 251) we showed that on the discharge of a cell, lead sulphate is the ultimate product on both plates.

It might naturally be inferred from our previous statements that in the re-charging of a cell this lead sulphate would be oxidated on the one plate and reduced on the other as in the original formation. This matter, however, has given rise to some controversy. All subsequent experimenters admit the *oxidation* of the lead-sulphate, but Dr. Oliver Lodge could not obtain any reduction of it, when pure sulphate was employed. Sir William Thomson also, when experimenting, with two platinum plates and layers of sulphate, obtained only a doubtful indication of reduced metal. The question as to whether the sulphate is reduced or not on re-charging a Faure cell is one of vital importance; for if the sulphate formed at each discharge accumulates on the positive plate it would clog up the space, and, what is perhaps worse, a fresh surface of the lead would have to be oxidated (or rather, converted into sulphate) at each discharge. Thus the positive plate will be continually corroded, and its life will be limited.

We have already replied to Dr. Lodge in NATURE (vol. xxvi. p. 342), but we thought it desirable to repeat the experiment with the platinum plates, especially with a view to determine whether the reduction was effected slowly or with any rapidity. We fastened 20 grms. of the white sulphate upon a negative plate by binding it round tightly with parchment-paper, placed it vertically in the sulphuric acid, and passed a continuous current of somewhat under an Ampère. The hydrogen was at no time wholly absorbed—indeed the greater part of it certainly escaped—but after the lapse of twenty-four hours, small patches of grey metallic lead became distinctly visible through the wet parchment-paper; and these gradually spread in an irregular manner. At the end of ten days it was found that the whole of the sulphate, except a few small patches on the surface, was reduced to a grey spongy mass. Although there could be no reasonable doubt that this was metallic lead, a portion of it was tested chemically, and proved to be such.

It thus appears that the *reduction* of the pure sulphate of lead is an absolute fact, although it does not take place so easily as the oxidation.

In an actual cell the sulphate of lead is of course mixed with other bodies. Thus, in the formation of a Faure battery, the minium is converted by the sulphuric acid more or less completely into peroxide of lead and sulphate. We have already described an experiment in which 4489 c.c. of hydrogen were absorbed on a plate, the materials of which were capable of absorbing only 4574 c.c., if the whole sulphate as well as the peroxide was reduced In our note-book we have the particulars of four other experiments made in each case with the same, or nearly the same, amount of material, in which 4199, 4575, 4216, and 4387 c.c. respectively were absorbed, although perhaps in not one of these cases was the experiment continued until the action was absolutely complete. As, however, it may be objected that the amount of sulphate produced upon these plates was an unknown quantity, we have in a recent experiment treated the minium in the first instance with a considerable amount of sulphuric acid. This gave us a mixture which, on analysis, was found to contain 18·5 per cent. of sulphate of lead. This mixture, when submitted to the reducing action of a current yielded a mass of spongy lead that contained only a mere trace of sulphate.

As it seemed desirable fully to establish the fact that the sulphate of lead formed on the discharge of a cell is reduced in the subsequent charging, we took the quondam lead plate of a fully discharged cell, determined the proportion of sulphate to unaltered spongy lead, and submitted it to the reducing action of a current. The amount of sulphate on the plate before passing the current was found to be 51 per cent., but, after the passage of a current, of about an ampère for 60 hours, not a trace of it remained.

Hence it may be concluded that, during the alternate discharging and re-charging of a Planté or Faure cell, sulphate of lead is alternately formed and reduced on the lead plate, and that the plate itself is not seriously corroded. It would, however, appear desirable not to allow the whole of the spongy lead to be reduced to sulphate during the discharge, for two reasons, viz. : (1) because the supporting plate stands a chance of being itself acted on if there is not a sufficient excess of spongy metal; and (2) because the presence of this excess tends to facilitate the reduction of the sulphate.

We have already shown that sulphate of lead is produced by the local action that takes place between the peroxide and its supporting lead plate during repose. The same local action also takes place during the charging of the plate, as was pointed out in our second communication, and this sulphate is, in its turn, attacked by the electrolytic oxygen. In this way the absorption of oxygen in forming the negative plate ought never to come to an end. In order to see whether this was the case, we allowed an experiment to continue for 115 hours, although the main action was over in about forty hours. For the last two days of the experiment, the amount of oxygen absorbed was pretty constant, being about 9 c.c. per hour, which is equivalent to 0·24 grms. of sulphate of lead formed and oxidated. The whole charge on the plate was forty grms. of peroxide. This local action also takes place during the discharge, as is evidenced by the sulphate of lead formed on the negative plate always exceeding in amount that formed on the positive plate.

Through this local action taking place during the formation of the cell, during repose, and during the discharge, the lead plate which supports the peroxide must be continually corroded more and more; and it is probably due to the insolubility of the sulphate formed that the destruction of this kind of secondary battery is so materially retarded in practice.

J. H. Gladstone
Alfred Tribe

REFLECTIONS ON READING "DEGENERATION": AN ESSAY, BY E. R. L., F.R.S.

The Ascidian came down like a wolf on the fold
In the ages ere Earth had grown wrinkled and old,
He peered through the waves with his cerebral eye,
Frisked his tail, and dashed after the innocent fry.

Like the leaves of the forest when Summer is green
That gay host of youthful Ascidians was seen,
Like the leaves of the forest when Autumn has blown
Their helpless descendants lie glued to a stone.

For the Angel of Darwin came, gentle and bland,
And lapped them in comfort and fed them by hand,
And their eye myelonic waxed useless and blind,
And their caudal appendage was cut off behind.

And there lies the sea-squirt with gill-slits all wide
And through them there eddies the nutritive tide,
Half mollusc, half vertebrate, solve him who can,
A riddle, a lesson for curious Man.

J. H. P.

ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION[1]

IX.

23. THE PIGMY HOG (*Porcula salvania*).—Few additions to the Zoological Society's living collection of late years have attracted more attention than the Pigmy Hogs of Nepaul, of which the first specimens ever imported into Europe reached the Gardens in May last.

For our first knowledge of the existence of this diminutive form of the pig-family in the sub-Himalayan forests we are indebted to the researches of Mr. Bryan H. Hodgson, formerly Resident at the Court of Nepaul, who described the Pigmy Hog so long ago as 1847, in an article published in the Journal of the Asiatic Society of Bengal. He named it *Porcula salvania*, from the forest of Saul trees (*Shorea robusta*), in which it is chiefly found. While the Wild Boar, or a species closely resembling it abounds all over India, the Pigmy Hog is exclusively confined, as Mr. Hodgson tells us, to the deep recesses of the primeval forests of the Terai of Nepaul and Bhotan, where it roams about in herds. It is very rarely seen even by the natives. A well-known hunter informed Mr. Hodgson that during fifty years' abode in the Saul forests he had obtained but three or four of these animals to eat, partly owing to their scarcity, and partly to the speed with which the females and young disperse, and to the extraordinary vigour and activity with which the males defend themselves while their families are retreating. Dr. Jerdon in his volume on the Mammals of India, tells us that the full grown males live constantly with the herd, which consists from five to twenty individuals, and are its habitual and resolute defenders against harm. These animals feed principally upon roots and bulbs, but also devour birds' nests, eggs, insects, and reptiles. The female has a litter of from three to four young ones. Dr. Jerdon adds, that whilst at Darjeeling, he in vain endeavoured to procure a specimen of it from the Sikkim Terai, and Sir Joseph Fayrer, who hunted many years in the Terai, was also unsuccessful in meeting with the Pigmy Hog.

Under these circumstances, it will be readily understood that the authorities of the Society have been much pleased at the recent acquisition of a small herd of these animals, consisting of a male and three females, of one of which we give an illustration (Fig. 23). They were obtained in the Western Dooars of Bhootan after vast trouble and expense, and were brought to England by Mr. B. H. Carew, who has parted with them to the Society. They were caught by Mr. Carew's hunters in snares which were set for them in hundreds, over a range of country twenty miles in extent. Though on their first arrival they were very wild, they are already becoming tame and confidential, and are, it is hoped, likely to breed.

In its general appearance the Pigmy Hog is not unlike a small variety of the common boar, but measures only about 1 foot 2 inches in length, and has but a very small tail. The colour is a nearly uniform brown, slightly shaded with dirty amber. The coat of hair is thin, except upon the back. The Pigmy Hogs will be found by visitors to the Zoological Society's Gardens in what is usually called the Ostrich House, just beyond the Zebra House, where a compartment has been specially fitted up for their accommodation.

---

[1] Continued from p. 134.

FIG. 23.—The Pigmy Hog.

24. **THE KOALA** (*Thascolarctos cinereus*). For many years was deemed impossible to keep the Koala, or Native Sloth of Australia, alive in captivity. Great and persistent efforts, it was said, had been made by many persons in various parts of the Australian Colonies to induce this curious little animal to submit to confinement. But as they never survived long, even under the most favourable conditions in Australia, it was hopeless to expect that we should ever see this animal living in London.

FIG. 24.—The Koala.

These prophecies, however, like other forebodings on more serious subjects, have turned out to be fallacious. In April, 1880, the Society acquired a living example of this animal in excellent health. It had been brought home from Australia along with a large barrel of the dried leaves of one of the gum-trees (*Eucalyptus*), upon which scanty diet, however, it appeared to have thriven well during the voyage. On being placed in a compartment of a room fitted up specially for it with branches to climb about upon, and supplied with fresh gum-tree leaves and a little bread and milk, it continued to prosper admirably, until it lost its life by an untoward accident.

The specimen had not been replaced until May last, when a second example, from which our Fig. (24) has been taken, was acquired of a London dealer, and seems, like its predecessor, likely to do well in this country under similar treatment.

The Koala is nocturnal or semi-nocturnal in its habits. In the daytime it is usually seen coiled up asleep on the topmost branch of its cage. In the evening it descends to munch the leaves of the *Eucalypts* provided for its food, but it never seems to be very active in its movements, and does not appear to have much intelligence.

In its native land, as we are told by Gould, in the first volume of his "Mammals of Australia," the Koala inhabits the dense and luxuriant bushes stretching along the south-eastern coast of the continent from Port Phillip to Moreton Bay, and the cedar-bushes of the mountain ranges of the interior. It is apparently confined to the south-east of Australia. It is recluse in its habits, biding in the day time in the dense foliage of the eucalypti or native gum trees, so that without the aid of the natives it is not easily detected. By these, however, it is readily discovered, and captured by the aid of their waddies or throwing-sticks. It is exceedingly tenacious of life, clinging to the branches after being shot until perfectly dead.

The Koala, when full grown, is about 2 feet in length, and about 18 inches in girth. The limbs are strong and muscular, and the long clawed feet are well adapted to its arboreal habits. On the fore-feet the two innermost toes are so arranged that they form, as it were, a double thumb, and act against the three outer, thus giving to the foot the grasping power of a hand; whilst on the hinder foot the inner toe is very large, nailless, and thumb-like, and acts against the four long-clawed outer toes in a manner resembling that of the thumb. The head is rounded and the muzzle short, the ears are not of large size, their prominent appearance being given to them by the very long hairs with which they are covered. These in the adult are fully two inches in length, and on the outer side of the ears are of the same grey hue as the rest of the body. The fur covering the body is long, soft, and rather woolly; the general colour may be described as ashy-grey, with an under-tint of brown.

FIG. 25.—The Cabot's Tragopan.

The natives of Australia are said to be very fond of the flesh of the Kaola, and readily join in the pursuit of it; they examine with wonderful rapidity and minuteness the branches of the loftiest gum tree, and upon discovering a Koala, they climb the treee with as much ease and expedition as a European would mount a tolerably high ladder. Having reached the branches, which are sometimes forty or fifty feet from the ground, they follow the animal to the extremity of a bough, and either kill it with a tomahawk, or take it alive.

Thus persecuted by the natives, and driven into the interior by the progress of civilisation, the Koala is now getting rare in many districts near the coast, where it was formerly abundant, and even for Australians the Gardens of the Zoological Society of London will shortly become perhaps the most convenient place to inspect this strange animal.

25. THE CABOT'S TRAGOPAN (*Ceriornis caboti*).—The Tragopans, or Horned Pheasants, constituting the genus *Ceriornis* of naturalists, must be ranked amongst the finest and most brilliantly coloured representatives of the splendid group of Indian game birds. Two of them—the Crimson Tragopan of the Central and Eastern Himalayas, and the Black-headed Tragopan of the Western Himalayas and Cashmere, are well known to Indian Sportsmen, and are familiar objects of pursuit, though we believe, by no means easily procured. The Crimson Tragopan was introduced into Europe by the Zoological Society in 1859, and has frequently bred in their Gardens, as has likewise the Temminck's Tragopan (*Ceriornis temmincki*), first received by the Society in 1864. Of the Black-headed Tragopans a pair was acquired in the spring of the present year, but this species, so far as we know, has not yet reproduced in Europe.

Between the furthest known eastern range of the Crimson Tragopan and the frontiers of China a fourth species of *Ceriornis* has its home. This is Blyth's Tragopan (*C. blythi*), first discovered in the Mishmi Hills by the late Dr. Jordin during his excursion to Assam in 1869, and subsequently met with by Major Godwin-Austen in the Naga Hills, south of the Brahmaputra. Blyth's Tragopan has likewise been once exhibited alive in the Zoological Society's Gardens, an adult male of this fine bird having been presented to the collection by Major Montagu in 1870. Little, however, is yet known of it.

The fifth and last species of Tragopan, which we now figure (Fig. 25), from an example lately acquired by the Zoological Society, is still more rare and little known than the four above-mentioned members of the genus. Cabot's Tragopan, as it is called, was described in 1857 by the late Mr. Gould, and subsequently figured in his great illustrated work on the Birds of Asia. Its habitat is South-Eastern China, but little is yet known of its exact range. The only naturalist who has met with it in its native wilds is the celebrated Chinese explorer, M. le Père David. M. David, in his "Oiseaux de la Chine," tells us that he found this fine Gallinaceous bird rather common in the wooded mountainous range which separates the provinces of Fokien and Kiangsi, when he traversed this district in the autumn of 1873, and obtained many examples for the French National Collection.

So far as has been recorded, the male specimen of this Tragopan, received by the Zoological Society in April last is the only example that has reached Europe alive.

THE ROT IN SHEEP, OR THE LIFE-HISTORY OF THE LIVER-FLUKE

THE winter of 1879-80 was marked by a widely-spread outbreak of the liver-rot amongst our sheep. The losses during that winter were estimated at three million sheep, or about one-tenth of the total number in the United Kingdom, and during the following winter the losses were equally severe. It had long been known that the disease was due to the presence in large numbers of a parasite called the liver-fluke (*Fasciola hepatica*) in the liver of the affected animals, and that the parasite invaded sheep or sometimes other animals allowed to feed on wet pastures, and especially on flooded ground. But notwithstanding that the question had been repeatedly investigated by numerous zoologists, including Prof. Leuckart, so well known for his researches on parasites, the manner in which the disease was incurred remained a complete mystery. It was known indeed that the animals most nearly allied to the liver-fluke, the digenetic Trematodes, presented an alternation of generations, and that they possessed larval forms infesting various species of molluscs. These nurse-forms, as they are called, produce internally larvæ, usually tailed, known as cercariæ, which leave the nurse and encyst themselves in some other mollusc or in aquatic insect larvæ, &c., and remain there quiescent, only reaching maturity if swallowed together with the animal harbouring them by some suitable vertebrate host. Such is a typical instance of the development of a trematode with alternation of generations, but there is a good deal of variety in the life-histories of the different species. It was supposed that the liver-fluke had a somewhat similar life-history, but all attempts to discover what mollusc served as intermediate host had been fruitless.

The Royal Agricultural Society of England was induced by the heavy losses of sheep in 1879-80 to offer a grant for the investigation of the natural history of this most destructive parasite. I undertook the research, and the results of my work during the summer and autumn of 1880 were published in the Journal of the Society for April 1881. Certain slugs had been suggested as probable bearers of the larval form of the liver-fluke, and I was able to show that these conjectures had little evidence to support them, and suggested that *Limnœus truncatulus* was really the intermediate host, or at least one of the intermediate hosts of the liver-fluke. For on the Earl of Abingdon's estate at Wytham, I examined thoroughly a clearly circumscribed area of infection situated on the side of a hill far above the reach of floods, and found that almost the only species of water-snail occurring on the ground was *Limnœus truncatulus*, found in a boggy spot. This contained an interesting form of cercaria, produced in a cylindrical redia, or nurse-form provided with digestive tract.

The free cercaria had a body of oval form, about 0·3 mm. ($\frac{1}{80}$ in.) in length, but was of very changeable shape. The two suckers characteristic of the adult forms of the family of the *Distomidœ* were of nearly equal size, the oral sucker about terminal, and the ventral sucker near the middle of the ventral surface. The anterior part of the body was covered, at least in the most mature examples, with exceedingly minute spines. But the most striking character of the cercaria was due to lobed lateral masses extending the whole length of the body on each side of the middle line. These lobed masses were an opaque white from the multitude of granules composing them. The cercaria had a tail, which, when fully extended, was more than twice the length of the body. It was exceedingly active, but soon came to rest, showing a strong tendency to encyst itself on surrounding objects. It contracted so as to assume a rounded form, and exuded a mucous substance, containing numerous opaque granules derived from the lateral masses described, which were thus shown to be a special larval organ, producing the substance of which the cyst was composed. The tail continued to wag violently, and was at length pinched off as it were by the hardening wall of the cyst. The cysts were snowy white by reflected light, but on rupturing them the included larvæ was found to be quite transparent. I had a few months previously seen a sheep which I had the best possible reason for knowing to be infected with flukes, wandering over the boggy spot from which the snail containing the cercaria came, and the presence of so highly developed an organ for the production of the substance of the cyst in a cercaria which encysted on any plants at hand, seemed to indicate that here was the cercaria of the liver-fluke, and it has since been proved that such was the case. Moreover, I had collected evidence from independent sources, which rendered it probable that the parasite was taken up by the sheep while grazing from the damp roots of grass, most likely in the encysted condition.

Of this cercaria I wrote at the time as follows:—"The structure and habits of this cercaria render it possible that it may prove to be the larva of *Fasciola hepatica*, but want of material has prevented my testing the question by giving the cyst to rabbits. I intend, however, to pursue this case further."

Accordingly, during the summer of 1881, I endeavoured to procure *L. truncatulus* in order to put my strong suspicion to the test of experiment. But I was unfortunately unable to find any, even in the localities where I had found it during the previous year. In my search I had on many occasions the skilled assistance of my friend and colleague Mr. W. Hatchett Jackson, but we never found any other trace of this species than the empty shells. The localities for the snail mentioned by Whiteave in his paper on the mollusca inhabiting the neighbourhood of Oxford, were searched, but without success. My friends at a distance were appealed to, but were unable to assist me. There can be little doubt that the freedom of sheep near Oxford from the liver-rot during last winter was directly connected with the real scarcity of this snail. This year, however, there were floods on the Isis in July, and *L. truncatulus* was brought down by the water in vast quantities, probably from marshy ground far up the river. So numerous were they that I repeatedly obtained as many as 500 specimens at a single sweep of a small hand-net. The low-lying meadows near the river were covered with the flood waters, and when these subsided the snails were left scattered broadcast over the fields. The snail is almost the smallest species of Limnæus; the variety which I found so abundantly was only a quarter of an inch long when fully grown. Although it is a water-snail it lives much out of water. My observations have convinced me that the individuals left by floods on the fields continue to live out of water so long as the ground is moist. Their numbers are recruited by others which crawl out of neighbouring ditches or streams. If a drought occurs they become dormant, but unless too long continued they revive with the first shower of rain.

On discovering these snails I immediately started infection experiments with them, and was at once successful. The adult fluke in the liver of the sheep or other mammalian host produces vast quantities of eggs. So prolific is it that I have estimated the number produced by each fluke to be at least several hundred thousand. The eggs pass with the bile into the intestines and are distributed over the fields with the manure. If the eggs fall on to wet ground, or are washed into a ditch, development continues, and after a time, the length of which depends upon the temperature, embryos are hatched out of the eggs. For the purpose of my infection experiments I obtained eggs from the livers of affected sheep, and kept them in water until the embryos were hatched, and then transferred them to vessels containing the snails to be experimented upon.

The embryo of the liver-fluke has the shape of an elongated cone with rounded apex; its average length is ·125 mm., or about 1/200 of an inch; its breadth at the anterior end about one-fifth of this. The broader end or base of the cone is always directed forwards, and in the centre of this a short retractile head-papilla. The whole of the surface, with the exception of the head-papilla, is covered with very long cilia, by means of which it swims, with head-papilla drawn in, swiftly and restlessly through the water. It is exceedingly active; sometimes it goes rapidly forwards, and then rotates on its longitudinal axis, just turning a little from side to side as if searching for something. At other times, by curving its body, it sweeps round in circles, or, curving itself still more strongly, spins round and round without moving from the spot. The cilia are carried by an outer layer of flattened ectoderm cells arranged in five or six transverse rings around the body, and are of the same length over the whole of the surface. The first ring is composed of four cells arranged around the papilla, and these are thicker than the other outer cells, often forming projections at the side of the embryo and resembling epaulets. Beneath these ciliated cells is the body wall proper, and within this are a number of delicate vesicular cells — the germinal cells. Behind the head-papilla is a rudimentary digestive tract. The body-wall contains, near the anterior end, a double eye-spot, composed of crescentic masses of dark pigment, placed with their convex sides turned towards each other.

When the embryo, in moving through the water, comes in contact with any object, it pauses for a moment, and feels about as if trying to discover its nature, and if not satisfied darts off hastily again. But if the object be a *Limnæus truncatulus* it at once begins to bore. Under ordinary conditions the head-papilla of the embryo is short and blunt, but as soon as the animal begins to bore it becomes longer, conical, and pointed. The embryo spins round on its axis, the cilia working vigourously and pressing the embryo against the surface of the snail. This pressure is increased by the body of the embryo being alternately drawn up and then suddenly extended. As the papilla sinks further into the tissues of the snail it becomes longer and longer until it reaches five times its original length, and the tissues of the snail are forced apart as if by a wedge, leaving a gap through which the embryo squeezes its way into the snail.

The embryo will not bore into all snails alike; the only other species which I have found it bore into from without is *Limnæus pereger*, and even here the specimens have always been such as were still very small. I have found embryos enter certain other snails, such as *Planorbis*, but only from eggs which had been swallowed by the snail and had been hatched in the digestive tract. This difference seems to be due to an instinctive choice on the part of the embryo, rather than to a greater softness of the tissues in *Limnæus truncatulus*. The tissues of *Physa fontinalis*, for instance, appear to be equally soft, but I have found that if these two species are placed in a small bulk of water with a very large number of embryos, the *Limnaei* will be found on dissection to contain fifty or more embryos, whilst the *Physæ* will be entirely free from them.

But although the instinct of the embryo seemingly prompts it to enter the right snail, it does not teach it to discriminate between the different parts of the snail's body, for I have found as many as a dozen embryos within the substance of the foot of a single *Limnæus truncatulus*. Such a position of course is not favourable to further development of the embryos, which, thus gone astray, soon perish.

The natural place for the further development of the embryo appears to be the pulmonary chamber, but they may also be found in the body cavity. Once safely lodged in the suitable locality, the embryo undergoes a metamorphosis. It loses the external layer of ciliated cells and changes from the conical to an elliptical shape. The eye-spots usually become detached, but they, as well as the head-papilla persist, showing the identity of the young sporocyst—for so it must now be called—with the embryo of the liver-fluke. The active embryo has degenerated into a mere brood-sac, in which the next generation is produced. The sporocyst increases rapidly in size, the round, clear cells contained within it increase in number, partly perhaps owing to the division of the germinal cells of the embryo, but also owing to a multiplication and subsequent detachment of the cells lining the inside of the body wall. As growth proceeds the contents of the sporocyst arrange themselves into round balls of cells, the germs of the second generation These germs increase in size, and assume first an oval and then an oblong shape, whilst a delicate cuticle is formed upon the surface. At one end a number of cells are arranged to form a spherical pharynx, which leads into a blind digestive sac. A little behind the pharynx the surface of the body is raised into a ridge, forming a ring surrounding the anterior end, whilst near the opposite end two short processes grow out. The germ has now become a redia, as the brood-sac or nurse-form provided with pharynx and intestine is called. The adult sporocyst is sac-shaped and reaches the length of ·6 mm.: it usually contains one or two rediæ nearly ready to leave, together with two or three larger and several smaller germs. There is another method of increase during the sporocyst stage, namely, by the division of a sporocyst into two others by a constriction separating the original one into two smaller ones. This method of multiplication, however, does not appear to be frequent in this species.

When the redia is ready to come forth, it breaks through the wall of the sporocyst, and the wound caused by its forcible exit immediately closes up, and the remaining germs continue to develop. The injury done by the parasites to the snails causes a serious mortality amongst them, especially at the time the rediæ begin to leave the sporocysts, for the former are much more active than the almost inert sporocysts, and migrate from the pulmonary chamber into the other organs of the snail, and particularly into the liver, upon which they feed. The rediæ can be observed with the microscope, through the trans parent shell, moving in the snail's liver. So great is the injury done, that in the laboratory, at any rate, very few snails survive three weeks from infection.

The redia increases in size, and may ultimately reach the length of 1·3 mm. or about one-twentieth of an inch. It resembles in every respect the rediæ I formerly described as found in the same snail at Wytham. Its contents of spherical cells arranged themselves into round germs as in the sporocyst, though I was able in this case to observe the formation of a gastrula. The germs at first were spherical, they then become oval, and afterwards they elongate still more, whilst one end becomes narrower than the other. The narrower end is partially constricted from the remainder, and, becoming long and slender, forms the tail of the cercaria, whilst the rest of the germ becomes the body. A sucker appears at the anterior end, and another of nearly equal size at the middle of the ventral surface of the flattened body, whilst within a digestive tract appears. This digestive tract is simply forked, and presents no trace of the lateral branches so characteristic of the adult.

The adult redia contains about a score of germs, but these are in very different stages of development. There are generally two or three nearly mature, the others in various stages down to small spheres of cells. Close to the raised ring surrounding the body of the cercaria there is a small opening as in all rediæ, by means of which the cercariae are destined to be liberated one by one as they come to maturity.

But not all the rediae produce cercariae, for they sometimes produce other rediae, and these daughter-rediae then give rise to cercariae. These latter, therefore, sometimes only appear as the fourth generation in the snail, and in one set of experiments I had reason to believe that no cercariae appeared earlier. It will thus be seen that a single embryo may give rise to more than a thousand cercariae.

In April of the present year Leuckart published a paper in the "Archiv für Naturgeschichte," where he described certain experiments on the development of the liver-fluke. He believed that *Limnaeus pereger* was the intermediate host, and had succeeded in infecting this species, though he had failed to rear the redia beyond the stage in which the contents were forming into spores. He had, however, obtained a number of *L. truncatulus* from a friend, and had found in them three different sorts of rediae. One of these contained tail-less distome larvae, and notwithstanding that the characters of the redia were very different from those reared from the embryo of the liver-fluke, he believed the conjecture that this was really the larva of the liver-fluke to be entirely justified until further results were obtained. The second form he considered might possibly be related to the liver-fluke, but the probability was far less than in the case of the tailless form. In his description of the third form I at once recognised the cercaria I had already found and suggested as the larva of the liver-fluke. Leuckart, however, did not consider that there could be any connection, because he failed to detect any spines on the surface of the body such as we should expect, and on account of the lobed lateral organs, which he thought might be the vitellaria of the adult.

I wrote a report of my own results as described above, giving them, however, in greater detail, for the October number of the Journal of the Royal Agricultural Society. This report was sent to the printer on the 1st of September, and a fortnight later received a revision which was merely verbal.

On October 9th a paper by Leuckart appeared in the *Zoologischer Anzeiger*, a periodical which gives rapid publication to important papers. In this Leuckart extends his former results, and states that he too has reared the cercaria of the liver-fluke in *L. truncatulus*, and finds that it is the form with the lobed lateral organs which he had already seen, and supposed to have no connection with the liver-fluke. It will be seen, therefore, that the cercaria of the liver-fluke is really the form found by me in *Limnaeus truncatulus* at Wytham, and described in the Royal Agricultural Society's Journal for 1881. It is interesting to see this result confirmed, not only by my own experiments, but also by Leuckart's independent investigations.

Leuckart has not been able to find any trace in the cercaria of the spines which cover the surface of the adult fluke. He has, however, found in the cells of the cercaria small rod shaped bodies closely resembling bacteria in shape and size, and thinks they may eventually be arranged in bundles and form the spines of the adult. But I have already stated that the anterior part of the body of the cercaria is covered with exceedingly fine spines, which can, however, only be seen in the most mature examples. The reason why Prof. Leuckart could not observe these spines was possibly because his examples were scarcely so mature. The rod-like bodies he mentions have certainly no connection with the spines of the adult. He states that they have never yet been found in other cercariae. I may perhaps be allowed to say that they have been described by three different observers, first by Wagener, then by Filippi in the cercaria of *Amphistoma subclavatum*, and by myself in the cercaria of the liver-fluke (described in April, 1881.

For further details of the structure and natural history of the liver-fluke, as well as the discussion of preventive measures, I may refer to my reports in the Journal of the Royal Agricultural Society.

A. P. THOMAS

University Museum, Oxford, October 13

A NEW CASE OF COMMENSALISM

CASES of Commensalism amongst the higher animals are rare. Those of the Prairie dog and Rattlesnake, in North America, and of the Burrowing Owl and Vizcacha in the Pampas of Buenos Ayres, are, however, familiar instances of it. The newly issued volume of the "Transactions and Proceedings of the New Zealand Institute" contains a communication from Prof. von Haast on a new and interesting case of two very different animals owning a common habitation.

One of these creatures being exceedingly scarce and little known, a few details upon this curious subject will be the more acceptable.

In December 1880, Mr. Reischek (a correspondent of Prof. v. Haast) paid a visit to a cluster of islands, called the "Chickens" situated East of Wangarei Bay on the East coast of the North Island of New Zealand. These Islands are now uninhabited by man but contain numerous remains of Maori Pahs and Kitchen-Middens showing that they were formerly much resorted to by the Natives.

The present inhabitants consist of certain species of birds, of which Mr. Reischek furnishes a list, and of multitudes of the celebrated Tuatara Lizard (*Sphenodon punctatus*)—one of the most anomalous forms of the Lacertian order, if, indeed, we are permitted by Dr. Günther to call it a Lizard at all.

Of these birds certain Petrels (namely *Procellaria gouldi*, *P. Cooki*, and *Puffinus gavius*) live in holes dug out by the Tuataras and keep apparantly on the best terms with them. The Tuatara, we are told, excavates its hole mostly on the western slopes of the Islands. The entrance to its chamber is generally four or five inches in diameter, and the passage leading to it often two or three feet long, first descending and then ascending again. The chamber itself is about one foot and a half long, by one foot wide and six inches high and is lined with grass and leaves. The Petrels and Tuataras have their nests separately, one on each side of the entrance, so that they in no way interfere with one another.

Generally the Tuatara lives on the right side and the Petrel on the left. Mr. Reischek says he sometimes found two Petrels inhabiting their side of the chamber but never two Tuataras together.

He is certain that the Tuataras in most cases excavate the holes as he watched them doing it, and moreover found them in holes only half finished without any birds with them. But there is no doubt that in some instances the Tuataras also inhabit holes dug out by the Petrels. Mr. Reischek likewise gives us some interesting facts about the Tuataras' habits.

During the daytime these lizards are seldom met with outside their holes, and never far from the entrances. But as soon as the sun has set, the Tuatara leaves its hole to seek its food, which consists of worms, beetles, etc. It also feeds on the remnants of fishes and crustaceans brought by the Petrel into the chamber. During the night, a peculiar croaking sound is heard emanating from these lizards, not unlike the grunting of a pig when it is tormented. This is the best time to catch the Tuataras. Mr. Reischek believes that the female *Sphenodon* lays its eggs in February, as in January he found in one of them eight fully developed eggs, and about the same time obtained a young one only eight inches long including the tail.

So little has been hitherto recorded concerning the habits of the Tuatara in a state of Nature that these facts ascertained by Mr. Reischek and communicated by Professor von Haast to the New Zealand Institute must be allowed to be of great interest. Although the Tuatara has not unfrequently been brought alive to this country, and there are at the present time two examples of it living in the Zoological Society's Collection, this reptile is already quite extinct upon the main-land of New Zealand and exists only in some of the more remote islets which border its northern shores.

THE COMET

I SEND a few sketches and a brief account of the comet Cruls. I found the comet at 11h. a.m. September 22, by sweeping the sky near the sun with the 10-inch refractor of the Observatory of Palermo. It was not an easy object to find; it seems but a point with a surrounding nebulosity, and a trace of tail directed to the south-west.

On the following morning the comet had the form (observed by Prof. Zona and myself) of Fig. 1, and preserved it until September 27; the tail was very splendid, inclined 50° to the horizon (that is to say, nearly parallel to the equator), a little convex to the south; the visible length in the glare of dawn and moon was 6°, and then 10°; the breadth at the top was 40′, and then 1° 18′. The nucleus was round and very brilliant, with a yellowish light.

FIG. 1.

The spectrum was formed of the linear continuous spectrum of the nucleus, traversed by a large and strong line, that of sodium (D); by enlarging the slit of the spectroscope, I saw a globular, monochromatic image of the nucleus and coma. Besides the line of sodium, many others were present, but my spectroscope not having a

FIG. 2.

micrometer, I did not determine them; I observed a band in the red, a line in the yellow near and after D, two others in the green, and an enlargement of the continuous spectrum of the nucleus in green and blue.

From the form of Fig. 1, the comet passed to that of Fig. 2 till October 1. The tail was more curved and diverging, inclined to the horizon a little more than 45°; the length was near 15°, the breadth at the top 1° 48′; the south edge was very much stronger and brighter than the north edge; an obscure streak seems to divide the comet through the whole length. The nucleus was less luminous; it appeared double, and lengthened to 25″, having a very brilliant jet directed to the sun.

The comet was not now as yellow as before, and corre-

FIG. 3.

spondingly in the spectrum the sodium line was very reduced and little luminous; but the usual three bands of the hydrocarbons—yellow, green, and blue—were very conspicuous.

From October 1 to the present time the comet approached the form of Fig. 3, which I observed this morning; around the nucleus and very excentrically to the north, it is a faint envelope; at the top of the south edge a sort of horn issued; the north extremity is 1° distant from *a* Hydræ. The length of the tail is 17°, the breadth 2° 48′.

The nucleus is much diminished and little luminous, and the colour of the comet almost white.

Besides the linear spectrum of the nucleus, the three bands of hydrocarbons extend 5′ round the nucleus.

The spectrum of the tail is continuous, and visible to the end.

It is remarkable that the changes of the spectrum (according to Dr. Hasselber's experiments) enabled me to predict that the comet had passed the perihelion before the orbit was calculated.

The beautiful sky of Palermo permitted me to observe the comet Cruls every day except October 5.

Observatory, Palermo, October 11 A. RICCO

NOTES

WE regret to learn the serious illness of Sir E. J. Reed. We were informed on Tuesday that there was no improvement in his condition, and that the doctor would allow no one to have access to him; yesterday, we understand, there was no change in his condition.

THE family of the late Prof. Balfour have presented his scientific library to the University of Cambridge, for the use of the morphological laboratory. It consists of rather more than 500 volumes, and 1100 pamphlets bound in 77 volumes. These include many most important original papers on morphology and embryology, which had been very carefully collected, and arranged according to subjects.

PROF. TACCHINI has recently visited London. We understand that he has been entrusted by the Italian Government with the arrangements for the Italian members of the expedition which will visit the Marquesas to observe the solar eclipse of May 6, 1883. Prof. Trépied, the director of the Observatory of Algiers, who also proposes to observe the eclipse, is now in this country.

WE understand that a new Lecture and Model Room has been appropriated in the Science School at South Kensington to the Metallurgical Department. But notwithstanding the great increase of the accommodation as compared with that formerly provided in Jermyn Street, the class is overflowing, several students having been unable to obtain admission.

ADMIRAL MOUCHEZ has decided to send MM. Henry, the well known astronomers, to the Pic-du-Midi Observatory, in order to report upon the practicability of establishing at this station (altitude 3200 metres) a permanent astronomical observatory. The investigation will extend over six weeks, and the two astronomers may possibly be detained by snow for a longer period.

THE installation of the set of magnetic instruments invented by M. Mascart has been completed, at Parc St. Maur Observatory, twelve miles from Paris. M. Theophile Moreau, one of the physicists of the Bureau Central, has been appointed to superintend the self-registering observations.

THE Conference on Electrical Measurement began its sittings on Monday at the French Foreign Office, under the provisional chairmanship of M. Duclerc, the Prime Minister, who delivered an address of welcome to the delegates and retired, when M. Cochery was nominated President of the Commission. The delegates for arranging for the security of cables afterwards opened their sittings; the two Commissions will meet on alternate days. It is believed the Commission for Electrical Measurements will appoint a sectional committee to conduct the scientific investigation, and that the work of the Cables Committee will be of short duration. A letter was read from Sir William Thomson, excusing the delay in his arrival. He will be in Paris to-day, ready to act in either Congress.

A LETTER received from Mr. Henry O. Forbes, dated July 12 last, announces that he was expecting to be landed next day at Larat, the mainland of Timorlaut on the east side. From all accounts Mr. Forbes was inclined to believe that the natives would be well disposed, and that he would have no difficulty in making collections in this *terra incognita*, towards the exploration of which 50*l*. was granted by the British Association at the Southampton meeting.

IN the neighbourhood of the Thuringian town of Kösen there are some disused saltworks with considerable water power. The latter is now to be utilised for the electric lighting of the town, and Kösen will thus be the first German town to introduce the electric light for illuminating the whole town.

THE foundation stone for a monument in memory of Columbus was laid at Barcelona on September 26.

LAST year an Anthropological Society was founded in Lyons, and the first number of its *Bulletin* lies before us. The Society works on much the same lines as the similar society of Paris. The *Bulletin* contains several good papers. Dr. Arloing writes on the influence of education in the development of the cranium of the dog; Dr. Lacassagne on the progress of criminality in France, and also on the history of sepulture among different peoples; M. Paulet on sepulture among ancient and modern peoples; and M. Lacassagne on tattooing. The Paris publisher of the *Bulletin* is G. Masson.

A SHOCK of earthquake was felt at Panama at midnight, October 12–13. A rather smart shock preceded by thunder occurred on Thursday last on the south side of the Lake of Geneva, between Thonon and Douvaine, and a slighter yet very perceptible shock was felt at Geneva on Friday night. A very distinct shock of earthquake is reported to have been felt at the village of Comrie, Perthshire, on Saturday morning, about three o'clock, and was followed by another and more severe shock about half-past seven. The disturbance was accompanied by a sound resembling the distant booming of a cannon, and appeared to pass from the south-west to the north-east.

THE 6th part of Prof. Dodel Port's "Atlas der anatomischen und physiologischen Botanik" has recently appeared, and the work is thus approaching completion. The new part contains the usual six large coloured plates. They illustrate *Phaseolus coccineus*, L.; *Elodea canadensis*, Gaspary; *Erythrotis Beddomei*, Hooker f.; *Cuscuta glomerata*, Choisy; *Peziza*; and *Endocarpon pusillum*. Parts 6 and 7 of the same author's "Illustrirtes Pflanzenleben" has also just appeared. This work will be completed with Part 10.

HARTLEBEN'S "Chemisch-technische Bibliothek," of which some 100 volumes have now appeared, is no doubt known to many of our readers. This enterprising firm has now entered upon a similar undertaking, viz. an "Elektro-technische Bibliothek," of which the first volume, entitled "Die magnetelektrischen und dynamoelektrischen Maschinen," by Gustav Glaser-de Cew, has just appeared. The "Electro-technische Bibliothek" will, for the present, be completed in ten volumes. The following will be their contents:—Vol. II. The transfer of electric force; Vol. III. Lighting and heating by electricity; Vol. IV. Galvanic batteries; Vol. V. Telegraphy; Vol. VI. The tele phone, microphone, and radiophone; Vol. VII. Galvanoplastics, electrolysis, and the preparation of pure metals; Vol. VIII. The electrical measure and precision-instruments; Vol. IX. The principles of electricity; Vol. X. Electrical formula.

THE encouraging results that were obtained in the way of optical communication between the frontiers of Morocco and the Spanish coast, a distance of about 300 km., have induced the idea of similarly connecting the islands of Mauritius and Réunion, and Mr. Adams (we learn from *Comptes Rendus*) is making preparations in Paris with that object. The principal station in Mauritius will be on the Plateau du Pouce, at an altitude of 750 m.; in Réunion, a spot has been selected near the lip of the crater of Nèfles, at 1130 m. The distance between the two stations is nearly 215 km. (say 134 miles). Mr. Adams is taking out two of Col. Mangin's large telescopic apparatus, with mirrors 0·60 m. in diameter. He means to use a so-called *automatic eclipser*, of the following arrangement:—A rule, with a number of equidistant holes in its upper surface, is moved along horizontally and regularly by a rack and pinion below. Pegs are inserted in certain of the holes, so as to produce long and short eclipses forming the letters of the Morse alphabet, by raising in turn a lever arm connected with a screen, which affects the telescopic apparatus. It is proposed to receive the luminous impression on a band prepared with gelatino-bromide of silver, passed uniformly at the focus of the receiving telescope. From Col. Mangin's experiments it appears certain that a petroleum lamp with flat wick, viewed edgewise, will be sufficient for the signals in question. With this method of signalling, if successful, it will often be possible to telegraph to Réunion the approach of a cyclone, twenty-four to thirty-six hours before it has reached Mauritius.

THE Cambridge University Press will shortly publish an illustrated volume on "The Fossils and Palæontological Affinities of the Neocomian Deposits of Upware and Brickhill," being the Sedgwick Prize Essay for the year 1879, by Walter Keeping, M.A., F.G.S. The "Lectures on Education" delivered before the University by Mr. J. G. Fitch, have now reached a fourth edition, which has lately been brought out at a reduced price for the use of teachers.

ON Sunday, the 8th inst., a large number of botanists in connection with the various natural history societies in the neighbourhood of Huddersfield, assembled at the Sun Inn, Highgate Lane, Lepton, and held a meeting specially for the display of the fungi of the district. The result of the day's hunt was arranged on tables in the large room, and the meeting being open to the general public, a large number of people assembled. Mr. Richard Jessop, president of the Lepton Botanical Society, was in the chair, and this gentleman gave a brief opening address. Messrs. A. Clarke and John Carter, of the Huddersfield Botanical Society, then named and described the fungi exhibited; these included the most known edible and poisonous species, and one plant of considerable botanical interest, viz. *Agaricus brevipes*, Bull. Several large dishes of fungi were then cooked by the landlady of the inn, and tested by the company: the flavour of each species being discussed and compared.

FOUR London Field Clubs, viz. the Hackney, Essex, Highbury, and Walthamstow Societies, visit Epping Forest in the neighbourhood of Chingford, on Saturday next, October 21, under the guidance of Dr. M. C. Cooke, Mr. Worthington G. Smith, Dr. H. L. Wharton, and Mr. J. English.

WE have received the first volume of the Spanish Cyclopædia, which is being brought out at Madrid by Mr. F. Gillman. It contains four extended treatises on Agriculture, Architecture, Anatomy, and Astronomy. The compilation appears to us to be done with care and conscientiousness, and the illustrations are good and profuse. The printing is well done, and the whole undertaking is creditable to Mr. Gillman.

THE chemistry of saké-brewing is described in a long and interesting paper by Prof. R. W. Atkinson, published by the University of Tôkiô as No. 6 of the Memoirs of their Science Department. The consumption of saké in Japan amounts to about six gallons per head per annum. The preparation of this liquid may be regarded as taking place in three stages. (1) Preparation of *koji*: rice is cleaned and the outer skin removed, it is then beaten or trodden with water, and lastly steamed; the embryo is thus killed and germination rendered impossible. The steamed rice is mixed with a little *tauc*, a yellowish powder, consisting of the spores of a fungus (*Eurotium oryzæ*), and the mixture exposed on trays for several days, during which time the temperature of the surrounding air and also of the mixed rice and fungus spores rises very considerably. These operations are conducted in underground chambers cut off from the influences of the outer air. *Koji* contains dextrose and dextrin, unaltered starch, mineral matter, and a diastase-like substance or substances; it converts cane-sugar partially into inverted sugar, and gelatinised starch into maltose, dextrose, and dextrin. (2) Preparation of *Moto*: steamed rice, *koji*, and water are mixed and maintained at a low temperature (0°–10°) for some time; the starch of the rice is thus for the most part changed into dextrose and dextrin. (3) Fermentation: the *moto* is heated by placing closed tubs of boiling water in the liquid; temperature rises, fermentation begins, and is continued for twelve or thirteen days by the introduction of fresh heaters; from time to time the mash is divided into portions, each of which is mixed with more *moto*, steamed rice, and *koji*, and then fermented. The fermented liquid is filtered, cleared by standing, and heated in order to prevent it from souring. Saké does not keep for any length of time in warm weather, and must be repeatedly heated by the brewer. The sudden occurrence of fermentation when *moto*, rice, and *koji* are heated is peculiar, as no ferment has been purposely added. Prof. Atkinson is inclined to regard the preparation of *moto* as being analogous to that of yeast in beer brewing; the ferment germs are being derived, he thinks, either from the air or from the grains of *koji* employed in the first part of the process.

MESSRS. SAMPSON LOW, MARSTON, AND CO. are about to publish a cheap edition of the illustrated re-issue of Gilpin's "Forest Scenery," edited, with notes bringing it up to date, by Mr. F. G. Heath, author of "Autumnal Leaves."

IN an interesting article on printing in China, the *North China Herald* says that the first great promoter of the art of printing was Feng Ying Wang, who in 932 A D. advised the Emperor to have the Confucian classics printed with wooden blocks engraved for the purpose. The first books were printed in a regular manner, and in pursuance of a decree in 953. The mariner's compass and rockets were invented about the same time, showing that at this period men's minds were much stirred towards invention. Twenty years after the edict the blocks of the classics were pronounced ready, and were put on sale. Large-sized editions, which were the only ones printed at first, were soon succeeded by pocket editions. The works printed under the Lung emperors at Hangchow were celebrated for their beauty; those of Western China came next, and those of Fokhien last. Movable types of copper and lead were tried about the same time; but it was thought that mistakes were more numerous with them, and therefore the fixed blocks were prepared. Paper made from cotton was tried, but it was found so expensive that the bamboo-made paper held its ground. In the Sung dynasty the method was also tried of engraving on soft clay and afterwards hardening it by baking. The separate characters were not thicker than ordinary copper coins. Each of them was, in fact, a seal. An iron plate was prepared with a facing of turpentine, wax, and the ashes of burnt paper. Over this was placed an iron frame, in which the clay types were set up until it was full. The whole was then sufficiently heated to melt the wax facing. An iron plate was placed above the types, making them perfectly level, the wax being just soft enough to allow the types to sink into it to the proper depth. This being done it would be possible to print several hundred or thousand copies with great rapidity. Two forms prepared in this way were ready for the pressman's use, so that when he had done with one he would proceed with another without delay. Here is undoubtedly the principle of the printing press of Europe, although western printers can dispense with a soft wax bed for types and can obtain a level surface without this device. Perhaps the need of capital to lay in a stock of types, the want of a good type-metal easily cut and sufficiently hard, and the superior beauty of the Chinese characters when carved in wood have prevented the wide employment of the movable types which are so convenient for all alphabetic writing. The inventor of this mode of printing in movable types five centuries before they were invented in Europe was named Pi Sheng.

THE manner in which the Chinese Government render the popular deities subservient to political ends has been noticed by Sir Alfred Lyall in a paper in the *Fortnightly Review* in the beginning of the present year. In a recent *Peking Gazette* we find an instance of how a deity is raised in rank for presumed public services. The military governor of Urumtsi prays the Emperor to confer a tablet on the deities of a mountain in his district, in recognition of various acts of supernatural interposition. In this mountain there is a large lake of unfathomable depth, upon the waters of which the inhabitants of the whole surrounding country rely for the irrigation of their lands. Of recent years, however, it appears the springs had shown signs of exhaustion, and much anxiety has been felt on this account. Last year a temple, dedicated to the divinities of the mountain, was erected, and scarcely had it been completed when the water in the lake rose more than a hundred feet, and has ever since afforded an unfailing supply of water. The assistance of these deities has been invoked with unvarying success on many occasions when locusts threatened to devastate the country, or when snow was urgently needed for the protection of the crops. The memorialist thinks that important services such as these should not go unrequited, and he begs therefore, in accordance with the expressed wish of the inhabitants, to address the Emperor on the subject. His Majesty replies graciously conferring the suggested tablet on mountain divinities.

THE Vienna municipal authorities have established a number of regulations for persons wishing to manœuvre a balloon. They are obliged to prove that they have gone through a course of instruction with a competent aëronaut, and have executed by themselves a number of successful ascents. Persons desirous to be passengers in a balloon are obliged to procure an authorisation from their wife and children, if any.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♀ ♀) from India, presented by Mr. A. Cornet; a Common Paradoxure (*Paradoxurus typus*) from India, presented by Sir Louis S. Jackson, F.Z.S.; a Golden Eagle (*Aquila chrysaëtos*) from Hudson's Bay, presented by Capt. Hawes; five Delaland's Geckos (*Tarentola delalandii*), four Millipedes (*Joulus*, sp. inc.) from Teneriffe, two Sharp-headed Lizards (*Lacerta oxycephala*) from Madeira, presented by Mr. A. D. Bartlett; a Galeated Pentonyx (*Pelomedusa galeata*) from South Africa, presented by Mr. W. A. Watkins; two Black Wallabys (*Halmaturus ualabatus*) from New South Wales, a Dormouse Phalanger (*Dromicia nana*) from Tasmania, a Grand Eclectus (*Eclectus grandis*) from Moluccas, a Red-sided Eclectus (*Eclectus polychlorus*) from New Guinea, purchased; a Rufous Rat Kangaroo (*Hypsiprymnus rufescens* ♂), a Squirrel-like Phalanger (*Belidens sciureus* ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE OBSERVATORY AT CHICAGO.—We have received from Professor G. W. Hough his annual report as director of the Dearborn Observatory at Chicago, for the year 1882. It is mainly devoted to the reduction and discussion of the numerous series of observations on the spots upon the disc of the planet Jupiter, made with the 18½-inch refractor, including measures for position of the great red spot, of equatorial white spots and other markings, and angles of position of the equatorial belt. The observations extend over the period from September, 1879, to March, 1882. Those made in 1879 and 1880 showed that the red spot was retrograding with accelerated velocity, and this drifting has continued with such uniformity, that Prof. Hough considers "the position of the spot at any future period can be very accurately computed." It was found that all the observations could be fairly represented by a period of rotation, varying directly with the time, and the discussion leads to the following formula:—

1879, September 25 + t × 0·00209s.,

which gives 9h. 55m. 35·9s. for the mean period between September 25, 1879, and March 29, 1882, comprising 916 days, or 2214 rotations of the planet.

Hence it is inferred that the apparent rotation-period has increased about four seconds since the opposition of 1879, showing a total drift of the red spot in longitude of 40,000 miles; and Prof. Hough regards his observations as evidence that the great red spot is not the solid portion of the planet. "An immense floating island," nearly 30,000 miles in length, and more than 8000 in breadth, has "maintained its shape and size, without material change, during more than three years." He has failed to recognise any fading of the colour of the spot, which on February 2 in the present year he judged to be a light pink, as formerly. Although the dimensions of the spot may not be said to have materially changed, the micrometrical measures do indicate a diminution in length to the extent of 0″·95 between the oppositions of 1879 and 1881, at which latter epoch it was 11″·30 (reduced to Jupiter's mean distance).

The direction of the south edge of the equatorial belt was nearly parallel with the planet's equator, as given in Marth's ephemeris; the north edge of this belt was found to be slightly concave.

The elliptical white spots were more numerous in 1882 than previously; but with the exception of two situate south of the red spot, they were seen with difficulty, and were only measurable under best vision. The two spots named were observed systematically during the three months from November 21, 1881, to February 23, 1882. The following of the two appeared to be at rest relatively to the red spot from November 22 to December 6, and subsequently to drift in the direction of rotation to the extent of about 41°; the average drift during the last two months was at the rate of fifteen miles per hour. The preceding spot also did not retain the same relative position in longitude with respect to the great red spot. Prof. Hough adds: "The observations of the small white spots during 1880 and 1881 prove that the whole surface of the planet outside the margin of the equatorial belt rotates with nearly the same rate." The approximate rotation-period for the principal white spot between the edges of the great equatorial belt was 9h. 50m. 9·8s. from observations over more than eight months, which is the same as for the second spot observed during 1880. Hence these equatorial white spots drift in the direction of the planet's rotation, at about 260 miles per hour, or through a complete revolution in about 45 days.

Twelve tinted drawings of the appearance of the disc of Jupiter accompany the report. The first of two made on July 3, 1880, shows the second satellite just entering on the great red spot at 15h. 43·5m., and the other, made nine minutes later, shows it nearly over its centre. A notch was formed so soon as the satellite touched the end of the red spot, and when completely entered, it appeared as white as when outside the planet's disc.

Mr. S. W. Burnham, who was at the Washburne Observatory during the summer of 1881, has returned to Chicago, and has recommenced his valuable measures of double stars with the large refractor. The present report has an engraving of this instrument, and of the tower of the Dearborn Observatory, in which it is mounted.

COMET 1882 *b* (FINLAY, SEPTEMBER 8).—The following positions of this comet are deduced from the elements published in NATURE last week:—

At 18h. Greenwich M.T.

	R.A.	Decl.	Log. distance from	
	h. m s.	° ′	Earth.	Sun.
Oct. 19	10 13 22	−15 7·3	0·1592	0·0466
21	10 10 39	15 54·2	0·1613	0·0640
23	10 7 53	16 40·4	0·1633	0·0804
25	10 5 3	17 26·0	0·1651	0·0959
27	10 2 8	18 11·0	0·1666	0·1106
29	9 59 7	18 55·5	0·1679	0·1247
31	9 55 59	−19 39·6	0·1690	0·1382

CHEMICAL NOTES

MM. HAUTEFEUILLE AND CHAPPUIS have obtained what appears to be pure liquid ozone, by compressing a mixture of oxygen and ozone at 125 atmospheres, and cooling the end of the capillary tube by a jet of liquid ethylene: on suddenly releasing the pressure, a drop of a very deep indigo-blue liquid remained in the end of the tube. The gas above this liquid was colourless, but as the last traces of liquid evaporated, the gas was seen to have a blue colour (*Compt. rend.* xciv. 1249).

IT is well known that sulphuretted hydrogen produces little or no precipitate in an aqueous solution of arsenious oxide: according to the experiments of Messrs. H. Schulze (*Journal für pract. Chemie*, 2, xxv. 431), such a liquid contains a colloidal form of arsenious sulphide. This colloid may be completely separated from dissolved arsenious oxide by prolonged dialysis; the solution, if dilute, is scarcely changed by long-continued boiling; the presence of free acids or of such soluble salts as chloride of potassium, iron, or chromium induces a change of the colloidal into an insoluble form of arsenious sulphide.

BY strongly compressing phosphoretted hydrogen in presence of water, and then suddenly decreasing the pressure, M. Cailletet has obtained a crystalline hydrate of this compound, the existence of which is conditioned by the temperature and pressure; the critical point, *i.e.* the temperature above which the substance cannot exist, whatever be the pressure, is 28°. Hydrates of sulphuretted hydrogen and of ammonia have also been obtained by this method (*Compt. rend.*, xcv. 58).

BY a somewhat similar process, M. Wroblewski has obtained a solid crystalline hydrate of carbon dioxide, $CO_2 . 8H_2O$: the experimental results of this author seem to show that at the pressure required to cause the absorption of carbon dioxide by water in the proportion indicated by the formula $CO_2 . H_2O$, the water would be entirely frozen, and therefore that this hydrate cannot be obtained by this method (*Compt rend.*, xciv, 1355).

"WHEN solution of two salts, capable of mutual action, are mixed, the solution contains four salts": it has hitherto been difficult to give a direct experimental proof of this generalisation made half a century ago by Berthelot. In the last number of the *Berichte* of the German Chemical Society (15, 1840) Herr Brügelmann describes the following experiments designed to prove the justness of Berthelot's statement:—Equal volumes of cold saturated solutions of cobalt chloride and nickel sulphate are mixed and allowed to deposit crystals by evaporation at ordinary temperatures; the crystals contain cobalt and nickel, but combined with sulphuric acid only. A mixture of solution of cobalt chloride and copper sulphate, prepared similarly to the preceding, deposits sulphate of the two metals almost free from chlorides. Copper sulphate and potassium dichromate solutions when mixed deposit crystals consisting almost entirely of sulphates of copper and potassium, the second crop of crystals contain a little chromate of the two metals, and the final crop is nearly free from sulphates.

THE "Compagnie Generale des Cyanures et Produits Chimiques" of Paris have issued a small pamphlet explanatory of the various technical applications of the salts known as sulphocyanates, which can be now readily manufactured in a state of purity. Sulphocyanate of aluminium is used as a mordant in alizarine dyeing; sulphocyanate of copper in the preparation of aniline black, and also, along with potassium chlorate and antimony sulphide, in the preparation of matches; sulphocyanate of potassium may be employed as a refrigerating material, as during the solution of 130 parts of this salt in 100 parts of water, temperature is lowered through 34°; sulpho-cyanate of ammonium is more effectual, weight for weight, as an antichlor, than hyposulphite of soda.

INVESTIGATIONS conducted at the Baden Aniline and Soda Works show that the change of orthonitrophenyl propiolic acid into indigo, which (as already explained in this journal) has been for the most part effected by grapes or with sugar, can also be produced by the agency of sulphides, sulphydrates, polysulphides, thiocarbonates, and especially the alkaline xanthates (*Chemisches Centralblatt*, 1882, 366).

GEOGRAPHICAL NOTES

NEWS has been received from the expedition of Dr. Emil Riebeck, dated July 7 last. It will be remembered that Dr. Riebeck, together with Dr. Schweinfurth made a thorough investigation of the island of Socotra, which was of high scientific importance. After this task was accomplished, the travellers separated, and Dr. Riebeck crossed to Bombay, travelled through large tracts of the Himalaya Mountains, remained for some time in Cashmere, then passed through the Ganges land, investigated Ceylon, and eventually undertook a special and detailed examination of the coast district of Aracan. He ascended the Karnasuli River from Tschittagong as far as the Hill tribes, to which Prof. Bastian has drawn special attention. He made many measurements, took numerous photographs and plaster casts of this highly interesting tribe, which is still living in a most primitive natural state. The climate, however, and particularly the frequent fording of rivers, soon told upon Dr. Riebeck's health. He contracted a fever, and had to be taken to Singapore. His valuable collections of zoological, anthropological, and ethnological specimens duly attracted the attention of geographers, and were frequently referred to at the recent "Geographentag." Since then Dr. Riebeck has continued his journey. Starting from Singapore, he is to follow the eastern coast of the Asiatic continent, then to cross over to Australia and New Zealand, and finally to return to Europe next summer by way of San Francisco and Panama.

TO the Berlin Geographical Society the other evening, Major von Mechow gave some account of his explorations during the last year or two in the region of the Coango. Leaving Berlin in September, 1878, accompanied by a ship's carpenter and a gardener, Major von Mechow arrived at Dundo on the Coanza in the following January; but, owing to various difficulties, it was the beginning of 1880 before he could start northwards into the interior at the head of 115 native carriers. Crossing and re-crossing the Cambo, and passing through various powerful and hospitable tribes, the German traveller, after a thirty-seven days' march, at last reached the Coango on July 19, 1880, and, under the guidance of the great chief Tembo Aluma, visited the magnificent Succambondu waterfall, which he named after the Emperor William. After canoeing it on the Coango for twenty-five days, Major von Mechow made a detour to pay his respects to the great Muene Putu Kassongo, by whom he was received in great state, and returning on September 19 to the river, he followed it to longitude 5 deg. 5 min., from which point the fear of his followers of the neighbouring cannibals compelled him to return. In forty-five days he again reached the abode of Kassongo, where he stayed some time, and at last arrived on February 20, 1881, at Malange, where he met his returning countryman, Dr. Buchner, as well as Herr Pogge and Lieut. Wissmann, who were both starting on a similar tour of exploration.

A GERMAN edition of Amici's "Morocco" has been published by Hartleben of Vienna. Herr von Schweiger-Lerchenfeld is the editor, and has to a considerable extent remodelled the work, adding interesting ethnographical and historical notes, and omitting passages and references which in the original work can only interest Italian readers, on account of their purely private and local character. Its scientific value is also considerably increased. Two new chapters have been added, one on Southern Morocco, the other on the war between Spain and Morocco in 1860, and these are not the least attractive ones in the book, quite apart from the geological interest attaching to the first one. Herr von Schweiger-Lerchenfeld describe Rohlfs' journeys in 1862 and 1864, the Oases of Tafilet and Boanan, the Draa district, the extreme south-western coast districts, the Wadi Sus valley, the journeys from Ktaua to the southern frontier, and from Tafilet to Igli, the Saura river, Beni Abbes and Karsas, the journey to the oasis of Tuat, In Salah, and numerous other subjects of geographical interest. His descriptions are graphic and full.

NEWS of the Danish Arctic Expedition has been received at Copenhagen, Tuesday night, up to September 22. The Expedition was then ice-bound near Mistni Island; but it was confidently hoped that the vessel would get free, and in any case there appeared then to be no danger.

AT its last sitting, the Geographical Society of Hamburg resolved to despatch a new expedition into the centre of East Africa. Its chief will be Dr. Fischer, who was one of Denhardt's companions in 1872, and remained behind at Zanzibar when his leader returned home. Dr. Fischer applied this summer to the Hamburg Geographical Society for means to enable him to cross the Snow Mountains, and then penetrate to the north of the Gallas regions, and as the enterprise seemed likely to favour the development of certain branches of the Hamburg trade, a sum of 15,200 marks was immediately subscribed for its furtherance.

THE "Thüringisch-Sächsische Verein für Erdkunde" held a general meeting at Kösen on October 1. Prof. Brauns (Halle) spoke on his travels in the mountain districts of Southern Japan; Dr. Nicolai (Jena) on the land and people between the Ruhr and the Wupper; Dr. Assmann (Magdeburg) on meteorological observations made on the summit of the Brocken.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—Although the new Statutes have come into force, regulating the courses given by the various teachers of science, and bringing the college tutors more or less under the control of the central authority of the Science Board, as yet no steps have been taken to form any of the new Boards of Faculties, and for this term at least lecturers only consult their own convenience and the wants of their particular pupils. In the Physical Department of the Museum, Prof. Clifton gives a course on "The Electricity developed when Different Substances are in Contact with one another;" Prof. Price gives a course on Optics; Mr. Stocker a course on Elementary Mechanics; and Mr. Heaton will form a class for the study of problems in elementary mechanics and physics.

At Christ Church Mr. Baynes gives a course of lectures on Electrical Testing, to be followed by a course of practical instruction in electrical and magnetic measurements.

At Balliol Mr. Dixon gives a course of lectures on Elementary Physics.

In the Chemical Department of the Museum Prof. Odling gives a course of lectures on Cyanogen and its Compounds. Mr. Fisher lectures on Inorganic, and Dr. Watts on Organic Chemistry. Mr. F. D. Brown will form a class for practical instruction in Organic Chemistry.

At Christ Church, Mr. Vernon Harcourt lectures and forms a class for practical work in Quantitative Analysis.

In the Biological Department of the Museum, Prof. Moseley continues his course on Comparative Anatomy. Each lecture is followed by a practical course in illustration of the lecture.

Mr. S. J. Hickson will lecture on some recent improvements in histological methods, each lecture to be followed by practical instruction. Mr. Morgan gives a course on the Teeth of Vertebrata, and Mr Barclay Thompson a course on the Vertebrate and Invertebrate Skeleton.

The Scholarship in Natural Science at Trinity College has been awarded to Mr. David H. Nagel, of St. Andrew's University; *proxime accessit*, Mr. H. T. O. Minty, of the Royal College of Science, Dublin. The following gentlemen have been named as distinguishing themselves in the examination:—Mr. J. Waddell, of Dalhousie College, Nova Scotia; Mr. F. L. Overend, of Manchester Grammar School; and Mr. T. H. J. Watts, of Llandovery School.

CAMBRIDGE.—To supply the place of a Demonstrator which the late Prof. Balfour had asked for, and to carry on his work during the current year, the Council of the Cambridge Senate have recommended that 300*l.* be placed at the disposal of the Board of Biological and Geological Studies for the year. Trinity College has appointed Mr. A. Sedgwick, who was lately Mr. Balfour's Demonstrator, and had the sole charge of the classes for two terms during Mr. Balfour's illness this year, to a lectureship for the current year, on conditions similar to those under which Mr. Balfour conducted his classes before his appointment to the professorship.

The following science lectures have been announced:—Professor Cayley, on the Abelian and Theta Functions; Professor Lewis, on Mineralogy and Crystallography; Mr. Muir, Caius College, on the Metals, and General Principles of Chemistry; Mr. Lea, on Chemical Physiology; Dr. Michael Foster, on Elementary Physiology; Mr. Langley, on Physiology and Histology, with practical work; these lectures will deal with protoplasm, the cell theory, theory of contraction, blood corpuscles, muscle, ciliated cells, nerve cells, endings of nerves, and the general physiology of nerve and muscle.

Mr. A. Sedgwick will give an elementary and an advanced course on the Invertebrata, with practical work. The advanced course will be given in conjunction with Mr. W. H. Caldwell, of Caius, College, and will extend over three terms.

Prof. Newton is lecturing on the Evidence of Evolution in the Animal Kingdom.

Prof. Humphry is lecturing on Osteology, and holds advanced classes in Anatomy and Physiology.

Messrs. A. G. Greenhill and R. R. Webb are appointed Moderators for the ensuing year.

Mr. W. N. Shaw (Emmanuel College) is appointed a member of the Board of Physics and Chemistry, and Messrs. A. Sedgwick and E. Hill are added to the Board of Biology and Geology.

Mr. R. Etheridge, F.R.S., and the Rev. E. Hill, are appointed adjudicators for the Sedgwick Prize.

The Medical Examiners for the year are, 1st M.B., Messrs. P. T. Main, W. Garnett, and S. H. Vines; 2nd M.B., Drs. Watney, Shuter, and A. M. Marshall; 3rd M.B., Drs. Reginald Thompson, Galabin, and Handfield Jones. Examiners in Surgery, Messrs. Luther, Holden, and T. Brayant; Assessor to the Regius Professor of Physic, Dr. Cheadle.

Messrs. R. S. Heath, Second Wrangler 1881, and A. E. Steinthal, Third Wrangler 1881, have been elected to Fellowships at Trinity College.

SCIENTIFIC SERIALS

Zeitschrift für wissenschaftliche Zoologie. Bd. 37, Heft i., August, 1882, contains:—On the development of *Asterina gibbosa*, Forbes, by Prof. Dr. Hubert Ludwig (with woodcuts and plates 1 to 8).—On *Marginella glabella*, L., and on the Pseudo-marginellidæ, by Justus Carrière (plate 9).—On the lateral canal system in *Cottus gobio*, by Dr. E. Bodenstein (plate 10).—On the coloration of the nestlings of the genus Eclectus (Wagl.), with a list appended of seventy-one papers on this somewhat vexed question, by A. B. Meyer.

Verhandlungen der k.k. zool.-botan. Gesellschaft in Wien, Bd. xxxii. Pt. 1 (January to June, 1882), contains, in addition to the proceedings of the Society, the following memoirs:—Zoology. By Dr. R. Bergh, contribution to a knowledge of the Aeolididæ, vii. (plate i.-vi.).—Dr. F. Brauer, on *Sympycna paedisca*, a justification of this as a new species.—Dr. R. Drasche, a revision of the types of Diesing and Molin in the Nematode collection of the Society (plates 7 to 9).—On Oxycoryina, a new genus of Synascidian (plate 13).—Helminthological notes (plate 12).—Count Keyserling, on new American spiders (plate 15).—Dr. Löw, the characteristics of the genera Aphalara and Rhinocola (plate 11). A revision of the palæarctic Psyllidæ, and on a new species of coccus (*Xylococcus filiferus*) (plate 16).—A. v. Pelzeln, on the export of birds from Borneo.—A. Wimmer, on some adriatic shells.—Botany: Dr. G. Beck. New Austrian plants (plate 14).—W. Vos, material towards a list of the fungi of Krains.—Dr. F. Arnold, in memory of F. X. Freiherr v. Wulfen, born November 5, 1728, died March 16, 1805.

Revue internationale des Sciences biologiques, August 15, 1882, contains—On modern Hylozoism, by Jules Soury.—On the structure and the movement of protoplasm in vegetable cells, by H. Frommann (in continuation).—On psychology and the labours of Broca, by M. Zaborowski.

Archives des Sciences Physiques et Naturelles, August 15.—On the rotatory polarisation of quartz (second part), by L. Soret and E. Sarasin.—Some new aromatic ketones obtained by molecular condensation, by A. Claparède.—On the quantity of hail that fell during the thunderstorms of August 21, 1881, and of July 13, 1788, and some words on the history of hail-preventers, by P. Dufour.

Gegenbaur's Morphologisches Jahrbuch, 8 Bd. Heft 1, 1882, contains:—Contributions to the morphology of the oral glands in vertebrates, by P. Reichel (plate 1) —On *Rhodope veranii*, Koll = *Sidonia elegans*, M. Schultze, by Prof. Dr. L. v. Graff (plate 2). This little animal, found on Ulva, at Trieste, belongs not to the Gastropods, as Kolliker thought, but to a section of the Rhabdocœla.—Notes on the calcareous skeleton in the Madrepores, by G. v. Koch (plate 3).—Contributions to the anatomy of the organs of vision in fish, by Dr. E. Berger (plates 4 and 5). Contains an account of researches made on one Cyclostomous nine Selachoid and nine Teleosteous fishes, and is accompanied by an account of the literature of the subject.

Niederländisches Archiv für Zoologie, Supplement Band 1, Lief. 3, 1882, contains a report on the sponges dredged up in the Arctic Sea by the *Willem Barents*, in the years 1878 and 1879, by Dr. G. C. J. Vosmaer, with four plates. Vosmaer differs from Sollas, though apparently without the same amount of material to judge from, regarding *Thenea muricata*, Bwk., as the same species as *Th. wallichi*. This very excellent memoir is written in good English, but as the sheets were not corrected for press by the author, several very perplexing mistakes occur, which are corrected in the appendix.—Report on the Echinoderms of the same expedition, by Dr. C. K. Hoffman, with one plate.—On the Nemertians of the expedition, by Dr. A. A. W. Hubrecht.—On the Gephyrea, by Dr. R. Horst, second portion, with two plates. *Stephanostoma barentsii* is described as a new species.—A catalogue of the Polyzoa, by D. W. J. Vigelius, with one plate.—On the Crustacea, by Dr. P. P. C. Hoek, with three plates.—List of the Mollusca, by Th. W. Van Lidth de Jeude; and list of the Birds, by Dr. H. Schlegel.

SOCIETIES AND ACADEMIES

London

Entomological Society, October 4.—Mr. H. T. Stainton, president, in the chair.—Two new Members were elected.—Mr. R. McLachlan exhibited nymph-skins of *Hagenius brevistylus*, Selys (a dragon-fly occurring in Texas).—Mr. C. O. Waterhouse stated that the beetle exhibited at the August meeting as destructive to beer-casks at Rangoon was not *Xyleborus Saxesenii*, Ratz., but *Bostrichus perforans*, Woll. A discussion followed as to whether wood-feeding beetles attack healthy as well as unhealthy trees.—Papers read Prof. J. O. Westwood, Further descriptions of insects infesting figs.—Mr. G. C. Lewis, A supplementary note on the specific modfications of Japanese *Carabi*, and some observations on the mechanical action of sun-rays in relation to colour during the evolution of species.

Paris

Academy of Sciences, October 9.—M. Blanchard in the chair.—M. Dumas communicated the results of the labours of the International Committee of Weights and Measures for 1882. The comparison of a new metre and kilogramme of iridised platinum with the old French standards of platinum proved very satisfactory (showing close similarity).—On a new theory of the sun, by Dr. C. W. Siemens, by M. Faye. He urges that gas rarefied to $\frac{1}{2000}$ would be, for the astronomer, a dense medium, presenting much greater resistance than is observed, to celestial movements. Moreover, the hypothesis adds 100000 times the mass of the sun, to those masses which celestial mechanics has hitherto reckoned so minutely.—On the shock of two spheres, having regard to their degree of elasticity, and to the friction developed on contact, by M. Ledieu. These chiefly apply to the prevalent notion of electromotive forces, (total or partial) and of currents.—Observations of the great comet (Cruls) at Marseilles Observatory, by M. Borrelly.—Theorems on the functions of an analytical point, by M. Appell.—On Fuchsian functions, by M. Poincaré.—On a series for developing the functions of a variable, by M. Halphen.—On the gravity-barometer, by M. Mascart. He made a rough trial of his instrument in a journey to the north of Norway. He finds that it is easily transportable, and that its precision is apparently not less than that obtained with the pendulum. One has merely to observe the mercury-level and the temperature, and the installation may be done in less than an hour in a hotel-room.—Transmission of work a great distance, on an ordinary telegraph-line, by M. Deprez. Between Miesbach and Munich (57 km.) he used two telegraph wires of galvanised iron 4·5 mm. thick. The total resistance of the circuit, including the two quite similar Gramme machines (each 470 ohms) was about 1900 ohms. In a first experiment, a work of 38 kgm. per second (or ½ a horse-power) was got directly at Munich with a velocity of 1500 turns a minute (the Miesbach machine giving 2200 turns). More than 60 per cent. of the work expended was recovered. Heavy rain fell all the time of the experiments. The receiving machine fed a cascade through a centrifugal pump. The heating after two hours was hardly appreciable.—Thermoscopic method for determination of the ohm, by M. Lippmann. This differs from Mr. Joule's calorimetric method in not requiring measurement of the quantities of heat, nor a knowledge of the mechanical equivalent of heat. After measuring the heat from passage of a current of known intensity through a wire in a calorimetric vessel, equal heat is developed by friction in the vessel, and from the work expended, and the intensity of the current, the electric resistance may be deduced.—On the rotatory polarisation of quartz, by MM. Soret and Sarasin. A new method is described, which yields results closely agreeing with those got before.—On experiments made to determine the compressibility of nitrogen gas, by M. Amagat. He notes important points of difference between M. Cailletet's method and his own (which some have affirmed to be quite similar), shows that the curves obtained are quite different, and contends for the greater accuracy of his own results.—On some combinations of bisulphide and biselenide of tin, by M. Ditte.—On the fermentation of nitrates, by MM. Gayon and Dupetit. Their experiments confirm the hypothesis that the reduction of nitrates, as well as nitrification, is a physiological phenomenon. Thus, in sewage water containing a little nitrate of potash, with some altered urine, the nitrate disappears gradually, and the liquid is filled with microscopic organisms. Chicken broth does better than sewage-water. (The presence of organic matters is necessary.) Carbolic acid and salicylic acid in antiseptic, or even higher doses, not only do not hinder the life of the reducing microbe, but themselves disappear completely with the nitrate.—Note on the transformation of amides into amines, by M. Baubigny.—On the decomposition of the tertiary acetate of amyl by heat, by M. Menschutkin.—Observation of the aurora borealis of October 2, 1882, by M. Renou. Accounts of the phenomenon were received from the Park of Saint Maur, from Nantes, Evreux, and Cherbourg.—M. Maumené said that black phosphorus appears nearly always in the first drops of phosphorus which distil in a current of hydrogen (prepared from zinc and sulphuric acid). The following drops are colourless and destroy the colour of the first by liquefying them and mixing with them. CO_2 does not give the phenomenon.

CONTENTS

THURSDAY, OCTOBER 26, 1882

SCIENTIFIC WORTHIES

XX.—JAMES PRESCOTT JOULE

JAMES PRESCOTT JOULE was born at Salford on Christmas-Eve of the year 1818. His father and his grandfather before him were brewers, and the business, in due course, descended to Mr. Joule and his elder brother, and by them was carried on with success till it was sold in 1854. Mr. Joule's grandfather came from Elton, in Derbyshire, settled near Manchester, where he founded the business, and died at the age of fifty-four in 1799. His father, one of a numerous family, married a daughter of John Prescott of Wigan. They had five children, of whom James Prescott Joule was the second, and of whom three were sons—Benjamin, the eldest, James, and John, and two daughters—Alice and Mary. Mr. Joule's mother died in 1836 at the age of forty-eight; and his father, who was an invalid for many years before his death, died at the age of seventy-four in the year 1858.

Young Joule was a delicate child, and was not sent to school. His early education was commenced by his mother's half-sister, and was carried on at his father's house, Broomhill, Pendlebury, by tutors, till he was about fifteen years of age. At fifteen he commenced working in the brewery, which, as his father's health declined, fell entirely into the hands of his brother Benjamin and himself.

Mr. Joule obtained his first instruction in physical science from Dalton, to whom his father sent the two brothers to learn chemistry. Dalton, one of the most distinguished chemists of any age or country, was then president of the Manchester Literary and Philosophical Society, and lived and received pupils in the rooms of the Society's House. Many of his most important memoirs were communicated to the Society, whose *Transactions* are likewise enriched by a large number of communications from his distinguished pupil. Dalton's instruction to the two young men commenced with arithmetic, algebra, and geometry. He then taught them natural philosophy out of Cavallo's text-book, and afterwards, but only for a short time before his health gave way in 1837, chemistry from his own "New System of Chemical Philosophy." "Profound, patient, intuitive," his teaching must have had great influence on his pupils. We find Mr. Joule early at work on the molecular constitution of gases, following in the footsteps of his illustrious master, whose own investigations on the constitution of mixed gases, and on the behaviour of vapours and gases under heat, were among the most important of his day, and whose brilliant discovery of the Atomic Theory revolutionised the science of Chemistry and placed him at the head of the philosophical chemists of Europe.

Under Dalton, Mr. Joule first became acquainted with physical apparatus; and the interest excited in his mind very soon began to produce fruit. Almost immediately he commenced experimenting on his own account. Obtaining a room in his father's house for the purpose, he began by constructing a cylinder electric machine in a very primitive way. A glass tube served for the cylinder; a poker hung up by silk threads, as in the very oldest forms of electric machine, was the prime conductor; and for a Leyden jar he went back to the old historical jar of Cunæus, and used a bottle half filled with water, standing in an outer vessel, which contained water also.

Enlarging his stock of apparatus, chiefly by the work of his own hands, he soon entered the ranks as an investigator, and original papers followed each other in quick succession. The Royal Society List now contains the titles of ninety-seven papers due to Joule, exclusive of over twenty very important papers detailing researches undertaken by him, conjointly with Thomson, with Lyon Playfair, and with Scoresby.

Mr. Joule's first investigations were in the field of magnetism. In 1838, at the age of nineteen, he constructed an electro-magnetic engine, which he described in Sturgeon's "Annals of Electricity" for January of that year. In the same year and in the three years following he constructed other electro-magnetic machines and electro-magnets of novel forms; and experimenting with the new apparatus, he obtained results of great importance in the theory of electro-magnetism. In 1840 he discovered, and determined the value of the limit to the magnetisation communicable to soft iron by the electric current; showing for the case of an electro-magnet supporting weight, that when the exciting current is made stronger and stronger, the sustaining power tends to a certain definite limit, which, according to his estimate, amounts to about 140 lbs. per square inch of either of the attracting surfaces. He investigated the relative values of solid iron cores for the electro-magnetic machine as compared with bundles of iron wire; and, applying the principles which he had discovered, he proceeded to the construction of electro-magnets of much greater lifting power than any previously made, while he studied also the methods of modifying the distribution of the force in the magnetic field.

In commencing these investigations he was met at the very outset, as he tells us, with "the difficulty, if not impossibility, of understanding experiments and comparing them with one another which arises in general from incomplete descriptions of apparatus, and from the arbitrary and vague numbers which are used to characterise electric currents. Such a practice," he says, "might be tolerated in the infancy of science; but in its present state of advancement greater precision and propriety are imperatively demanded. I have therefore determined," he continues, "for my own part to abandon my old quantity numbers, and to express my results on the basis of a unit which shall be at once scientific and convenient."

The discovery by Faraday of the law of electro-chemical equivalents had induced him to propose the voltameter as a measurer of electric currents; but the system proposed had not been used in the researches of any electrician, not excepting those of Faraday himself. Joule, realising for the first time the importance of having a system of electric measurement which would make experimental results obtained at different times and under various circumstances comparable among themselves, and perceiving at the same time the advantages of a system of electric measurement, dependent on, or at any rate comparable with the chemical action producing the electric current, adopted as unit quantity of electricity, the quantity required to decompose nine grains of water, 9 being the atomic weight of water, according to the chemical nomenclature then in use.

He had already made and described very important improvements in the construction of galvanometers, and he graduated his tangent galvanometer to correspond with the system of electric measurement he had adopted. The electric currents used in his experiments were thenceforth measured on the new system; and the numbers given in Joule's papers from 1840 downwards are easily reducible to the modern absolute system of electric measurements, in the construction and general introduction of which he himself took so prominent a part. It was in 1840, also, that after experimenting on improvements in voltaic apparatus, he turned his attention to "the heat evolved by metallic conductors of electricity, and in the cells of a battery during electrolysis." In this paper and those following it in 1841 and 1842, he laid the foundation of a new province in physical science—electric and chemical thermodynamics—then totally unknown, but now wonderfully familiar even to the roughest common-sense practical electrician. With regard to the heat evolved by a metallic conductor carrying an electric current, he established what was already supposed to be the law, namely, that "the quantity of heat evolved by it [in a given time] is always proportional to the resistance which it presents, whatever may be the length, thickness, shape, or kind of the metallic conductor," while he obtained the law, then unknown, that the heat evolved is proportional to the *square* of the quantity of electricity passing in a given time. Corresponding laws were established for the heat evolved by the current passing in the electrolytic cell, and likewise for the heat developed in the cells of the battery itself.

In the year 1840 he was already speculating on the transformation of chemical energy into heat. In the paper last referred to and in a short abstract in the *Proceedings* of the Royal Society, December, 1840, he points out that the heat generated in a wire conveying a current of electricity is a part of the heat of chemical combination of the materials used in the voltaic cell, and that the remainder, not the whole heat of combination, is evolved within the cell in which the chemical action takes place. In papers given in 1841 and 1842, he pushes his investigations farther, and shows that the sum of the heat produced in all parts of the circuit during voltaic action is proportional to the chemical action that goes on in the voltaic pile, and again, that the quantities of heat which are evolved by the combustion of equivalents of bodies are proportional to the intensities of their affinities for oxygen. Having proceeded thus far, he carried on the same train of reasoning and experiment till he was able to announce, in January, 1843, that the magneto-electric machine enables us to *convert mechanical power into heat.* Most of his spare time in the early part of the year 1843 was devoted to making experiments necessary for the discovery of the laws of the development of heat by magneto-electricity, and for the definite determination of the mechanical value of heat.

At the meeting of the British Association at Cork, on August 21, 1843, he read his paper "On the Calorific Effects of Magneto-Electricity, and on the Mechanical Value of Heat." The paper gives an account of an admirable series of experiments, proving that *heat* is *generated* (not merely *transferred* from some source) by the magneto-electric machine. The investigation was pushed on for the purpose of finding whether a *constant ratio exists between the heat generated and the mechanical power* used in its production. As the result of one set of magneto-electric experiments he finds 838 foot lbs. to be the mechanical equivalent of the quantity of heat capable of increasing the temperature of one pound of water by one degree of Fahrenheit's scale. The paper is dated Broomhill, July, 1843, but a postscript dated August, 1843, contains the following sentences:—"We shall be obliged to admit that Count Rumford was right in attributing the heat evolved by boring cannon to friction, and not (in any considerable degree) to any change in the capacity of the metal. I have lately proved experimentally that *heat is evolved by the passage of water through narrow tubes.* My apparatus consisted of a piston perforated by a number of small holes, working in a cylindrical glass jar containing about 7 lbs. of water. I thus obtained one degree of heat per lb. of water from a mechanical force capable of raising about 770 lbs. to the height of one foot, a result which will be allowed to be very strongly confirmatory of our previous deductions. I shall lose no time in repeating and extending these experiments, being satisfied that the grand agents of nature are, by the Creator's fiat, *indestructible*, and that wherever mechanical force is expended, an exact equivalent of heat is *always* obtained."

This was the first determination of the dynamical equivalent of heat. Other naturalists and experimenters about the same time were attempting to compare the quantity of heat produced under certain circumstances with the quantity of work expended in producing it; and results and deductions (some of them very remarkable) were given by Séguin (1839), Mayer (1842), Colding (1843), founded partly on experiment, and partly on a kind of metaphysical reasoning. It was Joule, however, who first definitely proposed the problem of determining the relation between heat produced and work done in any mechanical action, and solved the problem directly.

It is not to be supposed that Joule's discovery and the results of his investigation met with immediate attention or with ready acquiescence. The problem occupied him almost continuously for many years; and in 1878 he gives in the *Philosophical Transactions* the results of a fresh determination according to which the quantity of work required to be expended in order to raise the temperature of one pound of water weighed in vacuum from 60° to 61° Fah., is 772·55 foot lbs. of work at the sea-level, and in the latitude of Greenwich. His results of 1849 and 1878 agree in a striking manner with those obtained by Hirn and with those derived from an elaborate series of experiments carried out by Prof. Rowland at the expense of the Government of the United States.

His experiments subsequent to 1843 on the dynamical equivalent of heat must be mentioned briefly. In that year his father removed from Pendlebury to Oak Field, Whalley Range on the south side of Manchester, and built for his son a convenient laboratory near to the house. It was at this time that he felt the pressing need of accurate thermometers; and whilst Regnault was doing the same thing in France Mr. Joule produced, with the assistance of Mr. Dancer, instrument maker, of Manchester, the first English thermometers possessing such accuracy as the mercury-in-glass thermometer is capable of. Some of them were forwarded to Prof. Graham and to Prof. Lyon Playfair; and the production of these instruments was in itself a most important contribution to scientific equipment.

As the direct experiment of friction of a fluid is dependent on no hypothesis, and appears to be wholly unexceptionable, it was used by Mr. Joule repeatedly in modified forms. The stirring of mercury, of oil, and of water with a paddle, which was turned by a falling weight, was compared, and solid friction, the friction of iron on iron under mercury, was tried; but the simple stirring of water seemed preferable to any, and was employed in all his later determinations.

In 1847 Mr. Joule was married to Amelia, daughter of Mr. John Grimes, Comptroller of Customs, Liverpool. His wife died early (1854), leaving him one son and one daughter.

The meeting of the British Association at Oxford in this year, proved an interesting and important one. Here Joule read a fresh paper "On the Mechanical Equivalent of Heat." Of this meeting Sir William Thomson writes as follows to the author of this notice:—

"I made Joule's acquaintance at the Oxford meeting, and it quickly ripened into a life-long friendship.

"I heard his paper read in the section, and felt strongly impelled at first to rise and say that it must be wrong because the true mechanical value of heat given, suppose in warm water, must, for small differences of temperature, be proportional to the square of its quantity. I knew from Carnot that this *must* be true (and it *is* true; only now I call it 'motivity,' to avoid clashing with Joule's 'mechanical value.') But as I listened on and on, I saw that (though Carnot had vitally important truth, not to be abandoned) Joule had certainly a great truth and a great discovery, and a most important measurement to bring forward. So instead of rising with my objection to the meeting I waited till it was over, and said my say to Joule himself, at the end of the meeting. This made my first introduction to him. After that I had a long talk over the whole matter at one of the *conversaziones* of the Association, and we became fast friends from thenceforward. However, he did not tell me he was to be married in a week or so; but about a fortnight later I was walking down from Chamounix to commence the tour of Mont Blanc, and whom should I meet walking up but Joule, with a long thermometer in his hand, and a carriage with a lady in it not far off. He told me he had been married since we had parted at Oxford! and he was going to try for elevation of temperature in waterfalls. We trysted to meet a few days later at Martigny, and look at the Cascade de Sallanches, to see if it might answer. We found it too much broken into spray. His young wife, as long as she lived, took complete interest in his scientific work, and both she and he showed me the greatest kindness during my visits to them in Manchester, for our experiments on the thermal effects of fluid in motion, which we commenced a few years later."

"Joule's paper at the Oxford meeting made a great sensation. Faraday was there and was much struck with it, but did not enter fully into the new views. It was many years after that before any of the scientific chiefs began to give their adhesion. It was not long after, when Stokes told me he was inclined to be a Joulite."

"Miller, or Graham, or both, were for years quite incredulous as to Joule's results, because they all depended on fractions of a degree of temperature—sometimes very small fractions—his boldness in making such large conclusions from such very small observational effects, is almost as noteworthy and admirable as his skill in extorting accuracy from them. I remember distinctly at the Royal Society, I think it was either Graham or Miller, saying simply he did not believe Joule, because he had nothing but hundredths of a degree to prove his case by."

The friendship formed between Joule and Thomson in 1847 grew rapidly. A voluminous correspondence was kept up between them, and several important researches were undertaken by the two friends in common. Their first joint research was on the thermal effects experienced by air rushing through small apertures. The results of this investigation give for the first time an experimental basis for the hypothesis assumed without proof by Mayer as the foundation for an estimate of the numerical relation between quantities of heat and mechanical work, and they show that for permanent gases the hypothesis is very approximately true. Subsequently Joule and Thomson undertook more comprehensive investigations on the thermal effects of fluids in motion, and on the heat acquired by bodies moving rapidly through the air. They found the heat generated by a body moving at one mile per second through the air sufficient to account for its ignition. The phenomena of "shooting stars" were explained by Mr. Joule in 1847 by the heat developed by bodies rushing into our atmosphere.

It is impossible within the limits to which this sketch is necessarily confined, to speak in detail of the many researches undertaken by Mr. Joule on various physical subjects. Even of the most interesting of these a very brief notice must suffice for the present.

Molecular physics, as I have already remarked, early claimed his attention. Various papers on electrolysis of liquids, and on the constitution of gases, have been the result. A very interesting paper on "Heat and the Constitution of Elastic Fluids" was read before the Manchester Literary and Philosophical Society in 1848. In it he developed Daniel Bernoulli's explanation of air pressure by the impact of the molecules of the gas on the sides of the vessel which contains it, and from very simple considerations he calculated the average velocity of the particles requisite to produce ordinary atmospheric pressure at different temperatures. The average velocity of the particles of hydrogen at 32° F. he found to be 6055 feet per second, the velocities at various temperatures being proportional to the square roots of the numbers which express those temperatures on the absolute thermodynamic scale.

His contribution to the theory of the velocity of sound in air was likewise of great importance, and is distinguished alike for the acuteness of his explanations of the existing causes of error in the work of previous experimenters, and for the accuracy, so far as was required for the purpose in hand, of his own experiments. His determination of the specific heat of air, pressure constant, and the specific heat of air, volume constant, furnished the data necessary for making Laplace's theoretical velocity agree with the velocity of sound experimentally determined. On the other hand, he was able to account for most puzzling discrepancies which appeared in attempted direct determinations of the differences between the two specific heats by careful experimenters. He pointed out that in experiments in which air was allowed to rush violently or *explode* into a vacuum, there was a source of loss of energy that no one had taken account of, namely, in the sound produced by the explosion. Hence in the most careful experiments where the vacuum was made as perfect as possible, and the explosion correspondingly the more violent, the results were actually the worst. With his explanations the theory of the subject was rendered quite complete.

Space fails, or I should mention in detail Mr. Joule's experiments on magnetism and electro-magnets, referred to at the commencement of this sketch. He discovered the now celebrated change of dimensions produced by the magnetisation of soft iron by the current. The peculiar noise which accompanies the magnetisation of an iron bar by the current, sometimes called the "magnetic tick," was thus explained.

Mr. Joule's improvements in galvanometers have already been incidentally mentioned, and the construction by him of accurate thermometers has been referred to. It should never be forgotten that *he first* used small enough needles in tangent galvanometers to practically annul error from want of uniformity of the magnetic field. Of other improvements and additions to philosophical instruments may be mentioned a thermometer, unaffected by radiation, for measuring the temperature of the atmosphere, an improved barometer, a mercurial vacuum pump, one of the very first of the species which is now doing such valuable work not only in scientific laboratories, but in the manufacture of incandescent electric lamps, and an apparatus for determining the earth's horizontal magnetic force in absolute measure.

Here this imperfect sketch must close. My limits are already passed. Mr. Joule has never been in any sense a public man; and, of those who know his name as that of the discoverer who has given the experimental basis for the grandest generalisation in the whole of physical science, very few have ever seen his face. Of his private character this is scarcely the place to speak. Mr. Joule is still amongst us. May he long be spared to work for that cause to which he has given his life with heart-whole devotion that has never been excelled.

In June, 1878, he received a letter from the Earl of Beaconsfield announcing to him that Her Majesty the Queen had been pleased to grant him a pension of 200*l.* per annum. This recognition of his labours by his country was a subject of much gratification to Mr. Joule.

Mr. Joule received the Gold Royal Medal of the Royal Society in 1852, the Copley Gold Medal of the Royal Society in 1870, and the Albert Medal of the Society of Arts from the hands of the Prince of Wales in 1880.

J. T. BOTTOMLEY

COAL-TAR

A Treatise on the Distillation of Coal-Tar and Ammoniacal Liquor, and the Separation from them of Valuable Products. By George Lunge, Ph.D., F.C.S., Professor of Technical Chemistry in the Federal Polytechnic School, Zurich. (London: Van Voorst, 1882.)

A couple of centuries have just elapsed since the first English patent was granted to Becker and Serle for "a new way of makeing pitch and tarre out of pit coale, never before found out or used by any other"; and in 1742 a second patent was obtained by M. and T. Betton for the manufacture of "an oyle extracted from a flinty rock for the cure of rheumatick, and scorbutick, and other cases." Whether we have here a foreshadowing of the antiseptic method of treatment is impossible to say, but that there was virtue of another sort in coal-tar was fully recognised by the Earl of Dundonald, the father of brave Lord Cochrane, who, towards the close of the last century, set up tar ovens on a pretty extensive scale in Ayrshire.

What we know as the coal-tar manufacture is however practically an industry of the present generation: it is not even contemporaneous with that of the making of coal-gas, for during the earlier years of that manufacture the tar was counted as the most noxious of bye products to be got rid of by being burnt under the retorts or by being turned into the nearest stream. We have changed all that however, and to-day the tar is among those substances which, as Dr. Siemens pointed out the other day at Southampton, make the products of the destructive distillation of coal so much more valuable than the coal itself.

England is the great tar-producing country of the world; at the present time about half a million tons of tar are produced annually throughout Europe, of which we make about three-fifths. The distillation of coal-tar as a starting-point in the manufacture of colouring matters has indeed become one of our most important chemical industries. We however do not make these colouring matters although we are the principal users of them. Although Faraday first discovered benzene, and Mansfield gave his life in showing us how to isolate that substance on the large scale, and although Perkin led the way by the discovery of aniline purple, the first coal-tar colour; nevertheless the manufacture of the so-called coal-tar dyes has mainly centred itself in Germany. We send to the Germans the crude material, and they return to us the finished products. At the same time we also supply many of the chemicals necessary to transmute the baser substances into the costly dyes. In fact in this matter we are as mere hewers of wood and drawers of water; a circumstance which doubtless has not escaped the attention of the Royal Commissioners who are to report on the technical education of this country. We have not far to seek in tracing the cause of this: it is simply owing to the extraordinary development of chemical research in Germany arising largely from the attitude of the German universities towards scientific inquiry.

We have to thank Prof. Lunge for what is in reality the only monograph on this subject of tar distilling either in our own or in any continental language. Probably no one more fitted, both from practical experience and scientific knowledge, could have been found to undertake the work. Already in 1867 Dr. Lunge had published a treatise in German on the subject; this has now been elaborated into the present excellent work, which describes the processes of manufacture as carried on in the largest and best arranged tar and ammonia works in England and the Continent. In the preparation of the newer work the author has received much assistance from Mr. Watson Smith, who has extensive knowledge of these processes as carried out in Lancashire.

Chapter I. is mainly concerned with the origin of coal-tar; with historical notes on its applications, and with the general characters of the tars obtained from various sources. Much in this chapter, as indeed in other parts of the work, is of direct interest to the gas-engineer. An iron smelter has been defined as one who makes slag, and the economical production of cast-iron is very much a question of the economical production of the proper sort of slag. So important indeed are, nowadays, the "residual" products in the manufacture of coal-gas that a gas-engineer may with even greater truth be described as a maker of coal tar and ammonia-water, and we fully agree with Dr. Lunge that with the electric light looming in the near future, gas managers will have to consider the market prices of these "residuals," as influencing the mode of their manufacture, more carefully than they have hitherto done. They must in fact recognise that they are just as much makers of tar and ammonia as of coal-gas, and whether the one or the other is to be worked for must be governed by calculations depending upon the relative prices of gas and tar.

Chapter II. deals mainly with the properties of coal-tar and its constituents. A very complete list of these is given, and special attention is paid to their physical characters whenever these have been ascertained. Benzene, of course, is very fully described, even to an account of the rival theories of Kekulé, Claus, and Ladenburg as to its constitution. We entirely endorse Dr. Lunge's recognition of the enormous value of Kekulé's famous hypothesis in the development of the history of the aromatic derivatives; nevertheless the average tar distiller will, we are afraid, be lost in wonder and amazement at the idea of such fruitful consequences flowing from pictures of hexagons and prisms. In other words the description on p. 40 of the chemical constitution of the parent member of the aromatic group is far too bald to be of the slightest use to persons ignorant of the modern methods of representing constitution, and conveys no new information to those who know anything of such matters.

Chapter III. treats of the applications of coal-tar without distillation, such as its use for gas making, heating, and for the preservation of building materials and its use as an antiseptic, and in the manufacture of paints, varnishes, &c. Chapter IV. deals with the methods of distilling coal-tar, such as its distillation by steam and by fire. This and the next chapter (Chapter V.), on pitch, are extremely well illustrated by cuts and plates showing the best methods of constructing stills and condensing apparatus, mode of treating the gases and the different fractions, and a series of most valuable figures and tables are given of the results obtained in various works in England and on the Continent from different tars. Chapters VI. and VII. treat of anthracene and creosote oil, and considerable attention is given to the important question of the quantitative determination of anthracene and of the so-called coal-tar acids. Chapter VIII. is concerned with phenol or carbolic acid and naphthalene, and contains many valuable details as to the manufacture of carbolic acid hitherto unpublished: we would especially instance the careful description of the manufacture of pure phenol, as carried on in Lancashire which is furnished by Mr. Watson Smith. Chapters IX. and X. treat of what is technically known as "light oil" or "crude naphtha," and of its rectification by steam. The last chapter (Chap. XI.) is entirely devoted to the subject of gas-liquor, or the ammoniacal liquor obtained at the gas works by condensation in the hydraulic main and by washing the gas in the scrubbers. Ammonia is in fact one of the most important products of the destructive distillation of coal; indeed the supply falls very far short of the demand made by the employment of ammoniacal salts in artificial manures and in the manufacture of soda ash by the modern method. The price of sulphate of ammonia has been pratically doubled within the last twenty years. Whether ammonia will ever be produced commercially from the nitrogen of the air is a vexed question, but there is no doubt that if the coking of coals could only be carried out in a rational manner we might count upon an important addition to our stock of ammonia and of tar. It is indeed to this source that we must more immediately look for the increased supply so urgently needed.

Dr. Lunge has already enriched our literature by a most valuable treatise on another of our most important chemical industries, viz. the manufacture of alkali, and he has still further added to our debt by the publication of the present excellent manual. The work is extremely well got up, and deserves to be on the table of every gas manager and tar distiller in the kingdom.

T. E. THORPE

OUR BOOK SHELF

Tables for the Qualitative Analysis of "Simple Salts" and "Easy Mixtures." By Joseph Barnes. (Manchester: James Galt and Co.; London: Simpkin, Marshall, and Co., 1882.)

THESE tables are evidently compiled by one who has had considerable experience in teaching qualitative analysis; the directions are always clear and to the point; the student is not confused by too many alternative methods, neither is the art of analysis made altogether a matter to be learnt by rote. The short and simple solubilities table on p. 37 is especially to be commended. If we must have yet another set of tables for elementary qualitative analysis let us have these by Mr. Barnes; but have we not sufficient already?

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

The Comet

AT 4.30 this morning this comet was a most conspicuous and lovely object in the clear sky, in the south-east. With the assistance of Mr. Hodges and Mr. Percy Smith, the following details were obtained. The tail extended for quite 15° in length, and about 5° in width at its widest part, being slightly curved with the convexity downwards. The lower edge of the tail was very sharp, but the upper edge was gradually shaded off. The nucleus was considerably lengthened out in the direction of the tail to an extent of quite three times its width. Its estimated length was 10″.

On examination with the spectroscope, with the nucleus across the slit, there appeared a narrow continuous spectrum crossed by three bands, which I at once recognised as the usual hydrocarbon lines; the central one was the brightest, and I could see no other lines but these three.

5 a.m. October 23, 1882.

At 5.2 a.m. Greenwich time, the position of the nucleus was determined with the equatorial to be R.A. 10h. 9m. 33s., Dec. 16° 18′7″, being a mean of two observations.

I send sketches of the comet, a small star, which I have not identified, appeared in the field of view about 2′ 40″ from the nucleus as drawn, and if identified may assist to check the position of the nucleus as given by the circles.

The morning was exceptionally clear, so much so, that, at dawn, when we could read small print out of doors, 4th magnitude stars were clearly visible.
GEO. M. SEABROKE

Rugby, October 23

I INCLOSE a drawing made this morning after a prolonged examination (with a binocular) of the end of the comet's tail. Should you think the peculiar features which I have endeavoured to portray of sufficient interest to reproduce, the drawing is at your service. It is difficult to indicate truly features of this kind without exaggeration, if they are to catch the eye at all; but I am sure the exaggeration is very slight. The tail would seem to be about to end rather suddenly and with a broad end, when, from near the middle, shoots out, at a slight inclination to the general direction of the tail, a cleanly-shaded wisp. And as though this were due to a kind of cleft or parting, there is a corresponding broader sweeping-aside of the tail-end on the other side. One is at once reminded of the backward fraying of the broad side of a large feather. The effect is a decided enlargement of the end of the tail on one side, and a well-defined streamer shooting out at a slight inclination towards the other. The direction of the latter is such as to pass quite clear of the head, which is not a necessary consequence of its inclination, because of the curve which characterises the sharply-defined southern edge of the whole tail.

It is surely unusual for such decided features to present themselves at the very end of a comet's tail.

As a whole, the comet seems to have changed wonderfully little during the three weeks since I first saw it. Its change of place, also, is so moderate that, at this rate, there seems no reason why we should not see it for months yet. What if it should not vanish at all!
J. HERSCHEL

Collingwood, October 23

FOR several mornings past we have had fine views of the comet, first seen in England by Mr. A. Common. I inclose a sketch taken this morning, as accurate as I could make it with materials at hand.

It is chiefly remarkable (1) for the crescentic end of the tail, the lower or eastern horn being longer than the other; (2) for the distinctness of the shadow in the space beyond the tail, shadow obviously projected by the comet. Such a shadow I have never seen in any of the comets which have been under my observation during the last fifty years, nor do I recollect to have seen it described. (Here I have no access to books on the subject.)

The Comet from Cannes, October 21, between 5 and 6 a.m.

I presume that the propinquity of this comet to the sun is the reason why the shadow is unusually visible in contrast to the luminosity around it; but probably the peculiar clearness of our atmosphere renders the phenomenon clearer than it may be in England. In any case the appearance is interesting in relation both to the nature of cometary matter, and to that of light and shade in space.
C. J. B. WILLIAMS

Villa du Rocher, Cannes, France, October 21

THE comet was well seen here on Monday, October 23, for some considerable time about 5 a.m., though clouds occasionally hid part of it. I noticed the following:—1. The length that was clearly visible was such, that if the head had been placed on Sirius, the tail would have reached to Orion's belt. 2. The lower edge of the tail was comparatively sharp and brightly defined, while there was no well-defined upper edge. 3. At first sight the tail ended, fairly abruptly, in a short fork. But on glancing to one side, so as to allow the image to fall on a more sensitive part of the retina, one became aware that these two forks were continued in a very faint and hazy manner as far again as the length of the comet first noticed (mentioned and measured in (1.)) Or, more strictly, one became aware of a black rift in the sky behind the comet, in its direction, above and below which the sky was faintly luminous. One may say that at first sight the comet ended like a house-martin's, on more careful observation like a swallow's, tail. The *total* length of the comet thus seen was enormous; and the appearance suggested an even greater extension. W. LARDEN

Cheltenham, October 24

ALTHOUGH the fact is mentioned in NATURE of the 5th inst., that the comet was observed by Mr. Finlay, the First Assistant to the Astronomer-Royal at the Cape of Good Hope, at 5 a.m. on September 8, perhaps the following graphic account of its appearance, which I extract from a letter received this morning from my friend Mr. G. B. Bennett, dated Water-Hof, Cape Town, September 26, may have some interest. Mr. Bennett believed himself the earliest observer, but he does not consider the comet more conspicuous on this occasion than it was in 1843.

"I take an especial interest in our present visitor, as I fancy that I am the very first person who saw it, and this was on the 8th inst. at 5 a.m I was attracted into the garden by the marvellous brilliancy of the stars. On turning my eyes eastward I detected a stranger at once; it did not appear as a comet, but I knew that there ought not to be any large star in the spot occupied. It was about midway between *Alpherat* (Cor Hydræ) and Regulus; the latter, however, was not visible at the time I called to my daughter, and asked her to put her head out of the window, and she at once said, 'a comet.' I then wrote a note to the Editor of the *Cape Times* announcing it; this letter did not reach him, it would be long to explain why. . . . It is of such size and brilliancy as to be seen in the brightest sunshine. I saw it September 18 between noon and 1 p.m. Dr. Gill is reported to have said, 'the largest for 200 years.' I don't believe he said so; if so, he could not have seen the one of March, 1843."

My friend adds that he has ascertained most positively that it was not observed from the deck of either of the mail steamers *Athenian* or *Garth Castle*, then approaching the Cape. The latter carried Father Perry and the members of the Transit of Venus Expedition. "My belief is that it came within the ken of human vision on the morning of the 8th September, and not before." His station of observation, Waterhof, is about half-way up Table Mountain. J. H. LEFROY

October 19

REFERRING to my letter of the 16th, I beg to say that the R.A. of the "neighbouring object" should have been 10h. 11m., and that it was probably, not Schmidt's comet, as supposed, but the 7th or 8th mag. star 19980 Lalande, which does not appear in the B.A. Catalogue, or in the V.S. Catalogue, or in the large maps of the S.D.V.K., or on Mattly's Globe. It appeared to me of much greater magnitude than the above.

Bray, Co. Wicklow, October 21 WENTWORTH ERCK

THE magnificent comet now visible in our eastern sky shortly before sunrise is no doubt being observed in England. In case it should not I may add that its approximate position at 4h. 50m. a.m. (local mean time) this morning as determined by my equatorially mounted ($4\frac{1}{4}$ inch Cooke) telescope was R.A. 10h. 55m., South declination 3° 29′. The tail by estimation is about 14°, and of unusual breadth. The borders of the tail appear much brighter than the central part. H COLLETT

Lahore, The Punjab, India, September 25

The Proposed Bridge over the Forth

IT is no small evidence of the importance of this great undertaking, that the proposed scheme should have drawn from Sir George Biddell Airy such severe criticism as that which appeared in last week's NATURE. Coming from such a source, this criticism is sure, not only to receive the most careful consideration of those few who are sufficiently conversant with such matters to form their own opinion, but is sure to have great weight with the much larger class who accept the opinion of those they conceive best able to judge. It therefore behoves those who are responsible for this scheme, to make the best answer they can. Whether they will be able to remove altogether the impression adverse to the scheme, may well be doubted; but for my own part I do not anticipate that they will find much difficulty in meeting the objections raised, in so far as these are definite. It is not my present object to defend, or even to discuss the merits of the proposed bridge; what I wish to point out is that the knowledge of engineers as regards the theory of structures, is not so imperfect, or their methods of designing such guesswork as might be inferred from the tone of the criticism.

Sir George Biddell Airy expresses alarm lest in the design due consideration has not been paid to the "theory of buckling;" but whether this is so or not, does not appear from any circumstance to which he has referred.

To make a strut or "thrust-bar" 340 feet long to sustain a thrust of several hundred tons, is doubtless a stupendous undertaking, but so is a bridge to carry a railway over 1700 feet. There is, however, no theoretical reason against the possibility of such structures; that is to say, assuming the same strength and elastic properties of material as are experienced in existing structures, it appears by the application of the principles of mechanics that both such distributions and such quantities of material are possible as will assure the safety of these structures. Whether or not such distribution and quantities have been secured in the designs for these struts, could only be judged of after careful consideration of the proposed lateral sections in conjunction with the longitudinal section, and to these no reference whatever is made in the criticism.

That the experienced engineers who have made themselves responsible for this design can have overlooked such an important consideration as buckling is very improbable. There is no possible accident to structures which has received more careful consideration than buckling, or of which the laws have been more definitely ascertained.

The very pretty method, given in the appendix to the communication under consideration, for obtaining the formula $W = C \frac{\pi^2}{a^2}$ is a well-known application of the theory of elasticity, and is given by Bresse.[1] But this formula is known only to apply to prismatic bars very thin, compared with their length, and is therefore of little practical use. The laws of stiffness and strength for struts of a solid section, were first deduced by Eaton Hodgkinson from his own experiments, and have since been extended to struts of any section by Lewis Gordon and Rankine.

For wrought iron, putting P for the load, S the area of section, L the length, and r the least radius of gyration of the section about any line in that section, the units being inches and lbs., the formula is—

$$\frac{P}{S} = 36,000 \div \left(1 + \frac{l^2}{36,000\, r^2}\right).$$

From this it will be seen that L must be very large compared with r before this formula assumes the same form as that which Sir George Biddell Airy has obtained.

Such general formulæ are not, however, the only or the chief guides in modern construction; sufficient actual experience has been obtained as regards such a great variety of forms for the elementary parts of structures as to furnish rules for the proportioning of every class. And although any novelty such as unprecedented size furnishes matter for grave consideration, both as regards proportions and the possibilities of art, still the theory and data for assuring reasonable safety are available, and engineers must be much behind the day if they neglect these.

Owens College, October 21 OSBORNE REYNOLDS

I HAVE read Sir George Airy's criticism of the design for the proposed Forth Bridge with interest. So far as engineers are concerned the letter calls for no reply; but as others pardonably ignorant of the present state of engineering science may feel the

---

[1] "Cours de Méchanique appliqué," p. 210 (18 6.

same difficulties as Sir George Airy, I propose with your permission to offer a few explanations.

Sir G. Airy summarises his remarks under six heads, but I think two would have sufficed, viz. that the bridge was too big to please Sir George, and that the engineers were presumably incompetent. As to size, for example, Sir George considers the fact of the cantilever being "longer than the Cathedral by 175 feet is in itself enough to excite some fear," and even to "justify great alarm." But when I look for some justification for this bold statement I find that Sir George does not advance any reason whatever, nor make use in any way of his high mathematical attainments, but simply shifts the responsibility for this alarm on to the shoulders of the "citizens of London," asking, "would they feel themselves in perfect security? I think not; and I claim the same privilege of entertaining the sense of insecurity for the proposed Forth Bridge."

If Sir George had alleged that the stresses on the cantilever could not be calculated, or that the strength of the steel ties and struts could not be predicted, or that the cantilever could not be erected, I might have replied by publishing diagrams of stresses, results of experiments, and the names of the firms who have tendered for the work. I cannot, however, answer an argument based upon the supposed fears of the "citizens of London."

To prove that Sir George's criticisms imply a charge of incompetency on the part of the engineers, I need only point out that in one sentence he remarks that "experienced engineers must have known instances in which buildings have failed from want of consideration of buckling," and in another, that "there appears to be a fear of its occurrence in various parts of the bracket," when "the bridge will be ruined." Sir George's conclusions on this head are, however, as he fairly enough states, "made in the total absence of experiment or explanation," and in ignorance whether "a theory of buckling finds place in any of the books which treat of engineering." To assume, however, that an engineer is similarly ignorant, clearly amounts to a grave charge of incompetency. Again, how incompetent must the engineer be who required to be informed that the "horizontal action of the wind on the great projecting brackets depends not simply on the wind's pressure, but also on its leverage," or who neglected to provide for the consequent stresses. Yet Sir George does not hesitate to say, in reference to this, that "in the proposed Forth bridge there is a risk of danger of the most serious kind, which may perhaps surpass all other dangers."

As Sir George in the whole of his letter does not produce a single figure or fact in support of his very serious charges, I must, in justice to Mr. Fowler and myself, explain that it was from no want of data. At Sir George's request he was furnished with every necessary detail for ascertaining the maximum stress on each member, and the factor of safety. I stated in the paper referred to by Sir George at the commencement of his letter, that under the combined action of an impossible rolling load of 3400 tons upon one span, and a hurricane of 56 lbs. per square foot, the maximum stress upon the steel would in no case exceed 7½ tons per square inch. Any useful criticism must be directed to prove that such load is not enough or that such stress is too great. Nothing can be decided by appeals to the citizens of London.

Sir George's remarks about what he terms "buckling," and the "total absence of experiment," I can hardly reconcile with his having read my paper, because I have there devoted six pages to the question of long struts, and have given the results of the most recent experiments on flexure by myself and others. When he asks whether a tubular strut 340 feet long would be safe against buckling, he has evidently overlooked the twenty years' existence of the Saltash Bridge, which has a tubular arched iron strut 455 feet long, subject to higher stresses than are any of the steel struts in the proposed bridge. Reference is made to the fall of the roof of the Brunswick Theatre, which is attributed to buckling. This accident occurred about fifty-four years ago, and consequently considerably before my time; nevertheless I have heard of it often, and if I am not mistaken, the verdict of the jury was to the effect that the fall of the roof was due to a carpenter's shop weighing about twenty-five tons having been built on the tie-rod, which sagged under the weight, and so pulled the feet of the principals off the wall. However that may be matters little, as engineers are in possession of more recent and trustworthy data than the personal reminiscences of Sir George Airy. American bridges invariably have long struts, and consequently there is no lack of practical experience on the subject.

The late Astronomer Royal thinks that "the proposed construction is not a safe one," and hopes to see it withdrawn. When he wrote his letter it probably did not occur to him that rival railway companies might be only too glad to seize hold of anything which might prejudice the Forth Bridge project and alarm the contractors who were preparing their tenders for the work. I do not complain of Sir George's action, as it involves a matter of taste of which he is sole judge. I would only mention that when he penned the above sentence he had been furnished by the engineers with the Parliamentary evidence and other documents necessary to inform him of the following facts:—(1) That a wind pressure of 448 lbs. per square foot upon the front surface would, as stated in my paper on the Forth Bridge, be "required to upset the bridge, and under this ideal pressure, though the wind bracing would, it is true, be on the point of failing, none of the great tubes or tension members of the main girders would even be permanently deformed." (2) From the evidence given before the Tay Bridge Commissioners, Sir George, being a witness, would know that, even supposing the workmanship had been good, a wind pressure of about one-tenth of the preceding would have sufficed to destroy the Tay Bridge. (3) He would also remember, no doubt, his own report of 1873, wherein he says that "the greatest wind pressure to which a plain surface like that of the Forth Bridge will be subjected in its whole extent is 10 lbs. per square foot." (4) The Parliamentary evidence would have informed him that the proposed design was the outcome of many months' consideration by the engineers-in-chief of the companies interested, representing a joint capital of 225 millions sterling, and that it was referred to a Special Committee of the House of Commons and to a special Committee of the Board of Trade inspecting officers for examination and report, and that the reports of engineers and committees were alike unanimous in testifying to the exceptional strength and stability of the proposed bridge. As a sample of foreign opinion, I would quote that of Mr. Clarke, the eminent American engineer and contractor, who has built more big bridges himself than are to be found in the whole of this country, and who has just completed a viaduct 301 feet in height, by far the tallest in the world. Referring to the proposed bridge, he writes: "If my opinion is of any value I wish to say that a more thoroughly practical and well considered design I have never seen." I need hardly say that the opinion of such a man has far more weight than that of an army of amateurs.

Sir George Airy refers "unhesitatingly to the suspension bridge" as the construction which he should recommend. He has clearly learnt nothing on that head during the past ten years. In a report on the late Sir Thomas Bouch's design for the Forth Bridge on the suspension principle, dated April 9, 1873, he says: "I have no doubt of the perfect success of this bridge, and I should be proud to have my name associated with it." Chiefly on this recommendation, and in spite of numerous warnings from practical men, the bridge was commenced, but it had to be abandoned after spending many thousands, because having reference to the fate of the Tay Bridge, it was pronounced by the Board of Trade and every engineer of experience at home and abroad to be totally unfit to carry railway trains in safety across the Forth.

Sir George Airy stands alone in his advocacy of a suspension bridge for high speed traffic, and in his views as to the force and action of the wind on such a structure. That being so I may be permitted to say that I should have felt no little misgiving if he had approved of the substituted girder bridge, because it has been the aim of Mr. Fowler and myself to design a structure of exceptional strength and rigidity, differing in every essential respect from that with which Sir George evidently would still be proud to have his name associated.

B. BAKER

THE alarming observations in Sir George Airy's paper on the stability of the Forth Bridge as proposed by Mr. Fowler, which appeared in your last issue, seem to call for a reply, and I think I am in a position to make an unbiassed reply, as I had nothing whatever to do with the design, and moreover do not approve of it. I disapprove of the adopted system as one in which the distribution of the material can be economical only in a moderate degree, and I object to it from an æsthetic point of view, and also on account of some practical reasons of minor import, but I have no hesitation in asserting that the material may be so arranged in it—and very probably is so arranged—that the stability of the bridge when erected would equal that of the best existing structures of that class.

The paper referred to contains six points of objection, which are treated in a general way without attempting a scientific criticism. This is to be regretted considering the importance of the subject. I take each point in succession. With regard to

I. I cannot see an objection to the novelty of a system, if, as n this case, the conditions are unprecedented, and if the author of the paper himself is compelled to recommend a system of striking novelty.

II. What, may be asked, constitutes the enormity of magnitude of a structural part? Is it the excessive proportion of strain in it arising from its own weight to that arising from other weights and forces? If so, it will be found that this proportion may here be still very small, although it may not be ignored, as sometimes is done.

III. The experimental knowledge hitherto derived from structures with rising degrees of magnitude has not upset the theories used in the calculations of strength. It cannot be asserted that the top flange of a common rolled beam, being a strut, we assume twenty times as long as it is wide, would be under a test load in a safer position against buckling than the top flange of the Ohio girder bridge, which is 510 feet long and 20 feet wide, or the bottom flange of the Forth Bridge, which is 675 feet long and from 32 to 120 feet wide.

IV. We constantly rely on the strength of long struts; they exist in all girders, and many of them are of the same importance for the strength of the girders as the links for the strength of a chain. The theory of their strength, imperfect as it is, is applicable to all with a fair amount of truth, and there is no reason why it should not be applied equally to the struts in the Forth Bridge.

V. Assuming that the dangers from wind-pressure during the erection do not concern us here, it would be interesting to hear from the author which parts of the erected bridge would probably give way first, and whether this would take place by crushing, shearing, twisting, or pulling actions. The leverage offered to wind by the long brackets would come into question only when the pressure is different on the two sides of a pier. The difference would produce a twisting action, which would exist in the central pier, but which could be obviated in the two side piers. The resisting leverage of the central pier is 270 feet, or about two-thirds of the acting leverage. Approximately the same proportion obtains with regard to the stability against tilting under uniform wind-pressure, while in the case of the Tay Bridge the proportion was less than one-third.

VI. It is highly improbable that Mr. Baker should not have calculated his struts; in his book on the strength of beams, columns, and arches, he gives a very intelligible deduction of the theory of long struts, which, although elementary and not so elegant as that by the author, seems original. I have found deductions of that kind in most English text books, while in books of foreign origin generally the equation of the line of flexure is taken as the starting point. Its approximate form is—

$$-\frac{M}{E\,I} = \frac{1}{\rho} = \frac{d^2y}{dx^2}$$

M being the bending moment at any point, E the modulus of elasticity, I the moment of inertia of the section of the strut, and ρ the radius of curvature. The integration gives the limiting weight W acting endways upon a long strut, as already Navier stated it,

$$W = \frac{\pi^2}{a^2}E\,I$$

where $E\,I = C$ in the Paper. This formula is not applicable to short struts, since W might exceed the crushing strength of the material. The limiting weight W^1 for short columns is therefore calculated with $W^1 = f\,p$, where f is the sectional area and p the pressure on the sectional unit. Unfortunately there exists among theorists a difference of opinion as to the proper value of p; some put for it the crushing strength, and others the limit of elasticity, and now and then there are controversies going on about this matter. Meanwhile it is impossible to mark the limit between short and long struts which theoretically exists. Practically, however, the limit is indistinct, and Rankine, Gordon, and others, taking this into consideration, have put the two formulæ together into one empirical formula for W'', the limiting weight for struts of any given dimensions.

$$W'' = \frac{W^1}{1 + \frac{W^1}{W}}$$

This formula embellished with some empirical coefficients gives good results for struts of ordinary proportions, and as the struts in the Forth Bridge seem to have ordinary proportions, it is quite safe to use it for their calculation. M. AM ENDE

3, Westminster Chambers, Victoria Street, S.W., October 24

HAVING read with interest Sir G. Airy's article on this subject in the last number of NATURE, I am glad to see that it advocates a suspension-bridge in lieu of the proposed structure. It may perhaps interest your readers to give the particulars of the Great International Suspension Bridge over the Niagara River, which supports a carriage-way and a railway-track above.

The length of span between the towers is 800 feet. There are 4 cables, each composed of 3640 wires No. 9 = ·155" diam., without weld or joint; the cables are 10" in diameter. All the wires of each cable were separately brought into position, so that each one bears its full share of the tension. When a cable had been thus built up, it was tightly served with soft iron wire to bind the 3640 wires together, and to preserve them from rust.

Since this bridge was built, great improvements have been made in the manufacture of wire. Whereas the resistance to tensile stress at the moment of fracture of the best qualities of iron wire, such as that manufactured at Manchester for this bridge, does not much exceed 27 tons per square inch of section, *hardened and tempered steel wire* can now be made in large quantities and in long lengths with a minimum resistance at the moment of fracture of 90 tons per square inch.

Steel plates, rods, or bars cannot be made in quantity with a higher resistance than 34 tons, or less than half that of wire. Hardened and tempered steel wire similar to that used in pianos is thus clearly the most suitable material for suspension bridges, and has been recognised as such in America, where it is to be used in the construction of the New York and Brooklyn suspension bridge, the span of which is the same as the proposed Forth Bridge.

Our English railway engineers, however, have not yet recognised the great advantages wire possesses over any other form of material such as bars, chains, &c., for resisting tensile stress, and the further advantages that wire can be tested more easily and made of a more uniform quality.

Some ten years ago I called on Sir T. Bouch, the former Engineer to the Forth Bridge, to point out the advantages of a tempered steel wire suspension bridge over any other form of structure for the Forth Bridge. The idea was, however, nveer worked out on paper. WILLIAM H. JOHNSON

Manchester, October 23

On the Alterations in the Dimensions of the Magnetic Metals by the Act of Magnetisation

I HAVE read with interest Prof. Barrett's paper in NATURE, vol. xxvi. p. 585. Between his results as to the effect of magnetisation on the dimensions of bars of iron, of steel, and of nickel, and those of Sir William Thomson's experiments ("Electrodynamic Qualities of Metals," Part VII., *Phil. Trans.* R. S., Part I., 1879) on the effects of stress in the magnetisation of bars of the same metals, there exists a remarkable analogy, which, however, seems to break down in the case of cobalt. According to these experiments (which, I may mention, were carried out under Sir William Thomson's direction by my brother, Mr. Thomas Gray, and myself), the effect of the application of longitudinal pull to a bar of iron, while under the influence of inductive force tending to produce longitudinal magnetisation, is, for forces lower than a certain critical value, called from the Italian experimenter who first observed it, the Villari Critical Value, to increase, and of the removal of pull, to diminish, the inductive magnetisation. When the magnetising force exceeded the critical value, these effects changed sign, and tended to a constant value as the magnetising force was increased.

Again, the effect of transverse pull, produced by means of hydrostatic pressure in an iron tube, is, when applied, to *diminish* the longitudinal magnetisation, and when removed, to increase it. We see, then, from Joule's result, confirmed by

Prof. Barrett's, that the effect of longitudinally magnetising a bar of iron, or of increasing its magnetisation, is to increase its dimensions longitudinally and to diminish them laterally, so that the volume remains constant; and on the other hand, from Sir William Thomson's investigations, that the effect of increase of longitudinal dimensions in an iron bar is to increase, and of increase of transverse dimensions to diminish its longitudinal magnetisation.

This analogy holds also with reference to steel and nickel. In the case of bars of these metals, we found their longitudinal magnetisation to be diminished by the application of longitudinal pull, and Prof. Barrett has found that bars of the same metals undergo a shortening when their longitudinal magnetisation is increased.

In the case of cobalt, however, the results do not agree. The results for cobalt, given in Sir W. Thomson's paper, are somewhat anomalous, but they refer only to the effect of stress on magnetism in a bar which had been previously magnetised and then placed while being experimented on, under the influence of the earth's vertical force The results were therefore complicated by the effects of the stress on the residual magnetism. So far as these results go they bear out to some extent those found by Prof. Barrett, but further experiments, the results of which have not yet been published, prove that the effects of stress are the same as for nickel. This is the case at least for all but low magnetising forces.

The behaviour of cobalt and nickel throughout a wide range of magnetising forces, and under the influence of both transverse and longitudinal stress, will, it is hoped, be fully investigated in a continuation of Sir William Thomson's experiments, begun some time ago, and temporarily interrupted by other, and for the time being, more pressing work, but now about to be resumed.

I may mention that my brother and myself pointed out in NATURE, vol. xviii. p. 329, the applicability of a modification of Edison's Tasimeter to the measurement of the changes of dimensions produced in a body by magnetisation. We still think that this is perhaps the most simple method, and we have found it very sensitive for qualitative results. In our trials of it we have experienced some difficulty in obtaining a carbon button which would return after having been subjected to stress to the same resistance as before. The experiments of Prof. Mendenhall, however, show that the kind of carbon used by Edison in his Tasimeter possesses this property in perfection; and we hope soon by the use of this carbon to obtain quantitative results.

ANDREW GRAY

The Physical Laboratory, the University, Glasgow,
October 19

Aurora

AN aurora was seen at Croydon at about 7 p.m. on Wednesday, the 18th inst. Three streamers of a whitish colour could be traced distinctly across the whole of the sky while the moon was still up.

A. E. EATON

The Victoria Hall Science Lectures

THE popular science lectures at the Victoria Hall have proved quite sufficiently successful, so far, to make the managers wish to continue them, provided that the kindness of competent lecturers makes it possible to do so. There have been audiences each night of about 600—small compared with what the building will hold, but not amiss for a Friday night, in a neighbourhood where (except on Saturdays) people think twice before spending a penny. Those who have been present, agree in describing the audience as a peculiar one, for whom greater simplicity is needed than for the audiences of mechanics' institutes, and the frequenters of penny science lectures in general. They are quite ready to attend and to be interested, and do not think an hour too long, provided the ball is kept constantly moving, but as to this they are very exacting, and any breakdown of the apparatus, however temporary, places the success of the lecture in serious danger. There are stamps and whistles of impatience at any pause, such as must occur in adjusting experiments, but these cease the moment the lecture proper proceeds. This impatience perhaps makes the sustained interest of a lantern more suited to the audience than the more varied but intermittent experiments.

It is to be wished these lectures could be more widely known among the artisan class, who have not too many opportunities of hearing sound popular science.

ONE OF THE COMMITTEE

Royal Victoria Coffee Hall, Waterloo Road, S.E., October

THE TYPHOONS OF THE CHINESE SEAS[1]

THIS work by the learned director of the Zi-Ka-Wei Observatory, consisting of 171 pages quarto, and eight illustrative plates giving the tracks of the twenty typhoons of 1881, may be regarded as the outcome of the recent establishment of meteorological stations over the regions swept by the typhoon. The typhoons of 1880, amounting to fourteen, were described by Father Dechevrens in a previous paper. These two papers, from the greater fulness and accuracy of their details, form a contribution of considerable importance to the literature of cyclones.

An examination of the tracks of these thirty-four typhoons shows that they generally have their origin in the zone comprised between the parallels of 10° and 17°, some of them originating in the Archipelago of the Philippines, but the greater number to the eastward of these islands in the Pacific. The first part of their course is westerly and north-westerly; they then recurve about the latitude of Shanghai, and thence follow a north-easterly course over Japan. During the first half of their course the barometric gradients are steepest, and the destructive energy of typhoons is most fully developed; but after advancing on the continent, and, particularly after recurving to eastward, they rapidly increase in extent, form gradients less steep, and ultimately assume the ordinary form of the cyclones of North-Western Europe. In illustration of the steepness of the gradients sometimes formed, it is stated that on July 15 a gradient occurred of 2·760 inches per 100 miles, or one inch to 36 miles.

Typhoons do not occur during the prevalence of the north-east monsoon from November to May. In 1881 the typhoon season extended from May 22 to November 29. In Japan the true typhoon season is restricted to August and September, the storms there during the other months resembling rather the ordinary cyclones of temperate regions. The tracks of the typhoons during the months of moderate temperature, May, June, the latter half of September, October, and November, are the most southerly; they lie flattest on the parallels of latitude, and present a great concavity looking eastward; but those of the warmer months, July, August, and the beginning of September, exhibit, on the other hand, very open curves. This seasonal difference in the form of the tracks, taken in connection with the general form of the recurving tracks of the West Indian hurricanes, which are less open than those of the Chinese seas, suggests a possible connection between the forms of these curves and the different distributions of atmospheric pressure prevailing over the continents at the time.

Of the new facts brought forward in this report, the most important perhaps are those which show that the typhoon tracks have the feature of recurvation as distinctly as the hurricanes of the West Indies and the Indian Ocean. The degree of recurvation and the relative frequency with which it occurs in the tracks of the cyclones of the Chinese seas, the West Indies, the Indian Ocean near Madagascar, and the Bay of Bengal respectively, are important features in the history of these storms, which such reports will do much to elucidate. We shall look forward with the liveliest interest to Father Dechevrens' future reports, which from the lines of inquiry already indicated may be expected to throw considerable light on the influence of extensive regions of dry air and of moist air respectively, and of elevated

---

[1] "The Typhoons of the Chinese Seas in the Year 1881." By Marc Dechevrens, S.J., Director of the Zi-Ka-Wei Observatory, China. (Shanghai: Kelly and Walsh, 1882.)

table-lands, in determining the continuance and the direction of the course of cyclones; and the influence of isolated mountains and mountainous ridges in breaking up a cyclone into two distinct cyclones, which, from the difficulty necessarily experienced by seamen in interpreting the complex phenomena attending them, often prove so destructive in their effects.

SEISMOLOGY IN JAPAN

THE first earthquake that I ever felt took place about 2 a.m. on the night of April 10, 1876. On this night, which was soon after my arrival in Yedo, I had been installed in a new house. To be absolutely alone in a large partially furnished dwelling in a strange land, and then in the dead of night to be wakened by a swinging motion of the bedstead, a rattling of windows, creaking of timbers, and flapping of pictures was more than bewildering.

For some time after the motion had died away, which motion had several maxima and minima, some little rings upon the bedstead which had been caused to swing, kept up a gentle clicking, and a night light upon a basin of oil as it swayed from side to side cast long flickering shadows across the room. The general behaviour of things was ghostly, and it was some time before I could assure myself that what I had experienced was an earthquake.

Next morning, however, my doubts were dissipated by my neighbours making jocular inquiries about the nature of my experiences. Earthquake conversation, I may remark, is often used in Yedo to fill up the gaps in conversation, which in England are usually stopped by queries and truisms about the weather. This was my first earthquake.

Palmieri's instrument indicated that its direction was about E.S.E. to W.N.W., and its force was 6 degrees. By 6 degrees is meant that the shaking caused some mercury contained in a glass tube to wash up and down until a little string attached to an iron float on its surface had turned a pully and a pointer through 6°. By observing the tables of these indications it is seen that a very gentle shaking of long duration may get up a violent oscillation in the mercury and so indicate a shock of a great number of degrees, whilst a violent sharp shock, which might knock over a chimney, may possibly only indicate a few degrees.

Since my first earthquake I have had the opportunity during the last six years of studying rather more than 400 other shakings. One of these shook down chimneys, unroofed houses, twisted gravestones, and by its action generally entitled itself to be called destructive and alarming. The effect that this earthquake produced upon the nerves of many people was quite as great as that which might be produced upon children with an imaginary ghost. As residents in Japan are so often alarmed by earthquakes it is only natural that they should be led to study these phenomena. Amongst the first instruments which were employed for their investigation were, as might be anticipated, small columns, bowls of liquid, and other contrivances, which are found described in books and papers treating of observational seismology.

Columns which have been made of various shapes and various materials have been found unsatisfactory, because it is seldom (even when a house may be swaying violently), if they are on a stone platform *firmly* fixed to the ground that they are overturned. When it happens that they are overturned, if there were several columns side by side you would usually find them lying pointing like the arms of a star-fish in different directions. If an earthquake was a sharp blow, no doubt the columns would fall in the direction of the shock and also towards the point from which the shock came. Yedo earthquakes, however, commence gently, and the column is caused to rock before it falls, and as it rocks its plane of rocking may be gradually changed. Another explanation would be that some of the columns had fallen with direct shocks and some with reflected shocks, or that some were overturned with the normal and some with the succeeding transverse vibrations.

Bowls of liquid have been found impracticable; first, because it is seldom that in a bowl on a *firm foundation* a sufficiently measurable amount of washing up is obtained; and second, that any of the usual methods of registering the motion as well as many other methods, both chemical and mechanical which have been tried, are not satisfactory. Also there are the difficulties of freezing and evaporation to contend with.

Similarly the records of the old-fashioned ordinary pendulum with a pointer resting in sand, or, what is perhaps better, provided with a sliding pointer writing over a smoked glass plate, are also very unsatisfactory. All that many of the carefully drawn records produced by *swinging* pendulums appear to indicate, is that there has been an earthquake, and it has caused the pendulum to swing about. For reasons like these, after considerable experience the conclusion arrived at is that the records of most of the older forms of seismographs and seismometers, of which legions have been experimented with, can only be regarded as being *seismoscopic*.

When we look into the history of observational seismology, and take the following description of a seismometer invented nearly 1800 years ago as a standard of comparison between the old and better known forms of earthquake instruments for registering *ordinary* shocks, it is doubtful whether this branch of earthquake investigation has been much advanced. This description was given to me by Mr. J. Hattori, vice-director of the Imperial University. It was translated for me by my assistant, Mr. M. Kuwabara. It runs as follows:—

In a Chinese history called "Gokanjo," we find the following: "In the first year of Yōka (A.D. 136) a Chinese called Chioko invented a seismometer. This instrument consists of a spherically formed copper vessel (Fig. 1), its diameter being 8 'shaku.' It is covered at its top. Its form resembles a wine bottle. Its outer part is ornamented with the figures of different kinds of birds and animals and old peculiar looking letters. In the inner part of this instrument a pillar is so placed that it can move in eight directions. Also in the inside of this bottle there is an arrangement by which some record of an earthquake is made according to the movement of the pillar. On the outside of the bottle there are eight dragon heads, each of which contains a ball. Underneath these heads there are eight frogs, so placed that they appear to watch the dragon's face, so that they are ready to receive the ball if it should be dropped. All the arrangements which cause the pillars when it moves to knock the ball out of the dragon's mouth are well hidden in the bottle. When an earthquake occurs and the bottle is shaken, the dragon instantly drops the ball, and the frog which receives it vibrates vigorously. Any one watching this instrument can easily observe earthquakes. With this arrangement, although one dragon may drop a ball, it is not necessary for the other seven dragons to drop their balls unless the movement has been in all directions; thus one can easily tell the direction of an earthquake. Once upon a time a dragon dropped its ball without any earthquake, and the people therefore thought that this instrument was of no use, but after two or three days a notice came saying that an earthquake had taken place in Rōsei. Hearing of this, those who did not believe about the use of this instrument began to believe in it again. After this ingenious instrument had been invented by Chiokō, the Chinese Government wisely appointed a secretary to make observations on earthquakes."

We have here I think not only an account of an earthquake instrument which in principle is identical with many of our modern inventions, but the science has been conjoined with art. The record of the Chinese Government establishing a seismological bureau at a time when America was unknown, and half of Western Europe were living in the woods, is also interesting. Experience having taught us that the older instruments told us so little about the *actual* movements which were going on at the time of an earthquake, a large number of instruments to replace them have been gradually invented. Of these I may mention the three following types.

FIG. 1.

1. Pendulums, so far controlled by friction as to be "dead-beat," provided with an index which magnifies the earth's motion. The general construction of one of these instruments will be understood from Fig. 2. B B is a heavy lead ring, used as a pendulum; *p* a sliding pointer loaded with lead (so that it may give sufficient friction), resting on a glass plate on the pendulum. This pointer is carried by an arm attached to the side of the box containing the pendulum. Its object is to control the swinging of the pendulum. P the index, axled near the centre of gravity, C, of the pendulum, and again a short distance below at A in an arm attached to the side of the containing box. At the lower end of this index there is a sliding needle, N, to write on a moving or stationary glass plate. The magnification of the actual motion of the earth in this instrument is as C A : A N.

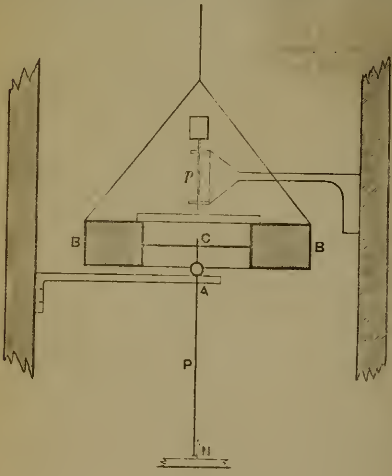


FIG. 2.

2. *Bracket Machines* (see Fig. 3). B is a heavy weight pivoted at the end of a small bracket, C A K, which bracket is free to turn on a knife edge K above, and a pivot A below, in the stand S. At the time of an earthquake B remains steady, and the index P forming a continuation of the bracket, magnifies the motion of the stand, which is to that of the earth in the ratio of A C : C N. These instruments are used in pairs, the brackets in each being placed at right angles to each other.

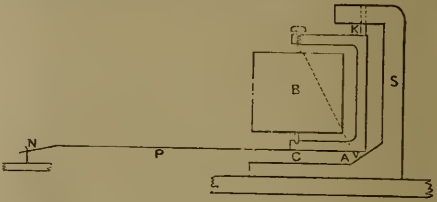


FIG. 3.

3. *Rolling Spheres* (Fig. 4). S is a segment of a large sphere with a centre near C. Slightly below this centre a heavy weight, B, which may be a lead ring, is pivoted. At the time of an earthquake C is steady, and the earth's motions are magnified by the pointer C A N in the proportion of C A : A N. The working of this pointer or index is similar to that of the pointer in the pendulum.

The indices of all these instruments, of which there are many modifications, are allowed to write on smoked glass plates, which at the time of an earthquake are either being moved by clockwork or else are stationary. For *vertical motion*, sunken buoys, the water in a can with a flexible bottom, and a weight suspended at the end of the long arm of a lever and stretching a stiff spring, have all been used with more or less success as steady points in the recording of vertical motion.

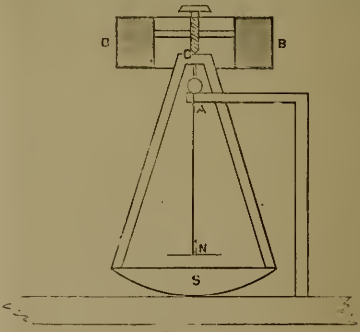


FIG. 4.

For the invention of the greater number of these instruments, which I may remark have already done very much in writing down actual earthquake motion, we are indebted to Mr. T. Gray. Messrs. Ewing, Chaplin, Wagner, and other members of the Seismological Society of Japan, have also made valuable contributions to this part of the subject.

Some of the more important results which have been arrived at by the use of these and other instruments are:—

[illegible]

James Prescott Joule

Engraved by C. H. Jeens

London: Published by Macmillan & Co.

1. That the earthquakes in Tokio usually commence gently, the motion is irregular, both as regards space and time, increasing and decreasing. Finally it dies away as it commenced.

2. There are usually from two to three vibrations per second. Occasionally there may be six or eight.

3. The maximum amplitude of an earth particle is seldom over one millimetre, although buildings may swing through several inches. When the amplitude is four or five millimetres, and the motion rapid, the shock may be dangerous.

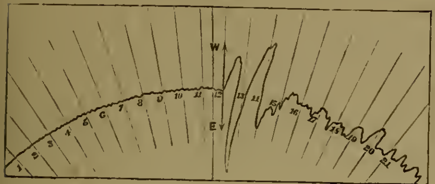


Fig. 5.

4. During a given shock the direction of motion may change, apparently showing the presence of normal and transverse vibrations.

5. The motion of the ground *inwards* towards the origin of the disturbance has in certain cases been much greater than the motion outwards. In this respect the diagram obtained from an actual earthquake closely resembles the diagram obtained when we explode a charge of dynamite in a bore hole.

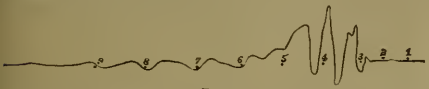


Fig. 6.

6. The velocity, and with it the acceleration for the inward motion, is usually much greater than it is for the outward motion.

In addition to these characters, earthquake motion has others which are more complex, and are now forming a subject of examination. Thus, for instance, experiment apparently indicates that two neighbouring points of ground (say at the distance of two feet from each other) do not synchronise in their motion. This would indicate that a building, although it may be small, may not be moved back and forth as a whole, but may suffer considerable racking.

Fig. 7.

The intervals in time between the actual earthquakes, which on the average occur from six to ten times per month, have been filled up with experiments upon artificially produced earthquakes, made by exploding charges of dynamite and gunpowder in bore holes. These experiments, in which the vibrations of the ground produced by the explosions have been simultaneously written down at a number of different stations, have perhaps been more instructive than the actual earthquakes. They have been to seismology what laboratory experiments on magnetism have been to the student of the magnetic phenomena of the earth. Not only have results similar to those which have been enumerated for actual earthquakes been obtained, but also many others. Thus it is found that in the alluvium of the Tokio plain a surface *wave* is produced, as might be inferred from the fact that the observation of the horizontal and vertical components of the motion of the ground, do *not* enable us to deduce angles of emergence for the shock and the depth of its origin. Normal and transversal vibrations have been clearly separated. The effect produced by inequalities in the surface of the ground in cutting off the propagation of vibrations have been studied. *Small* hills appear to produce but a slight effect, whilst cuttings (like a deep pond) are more or less effective in interrupting a disturbance.

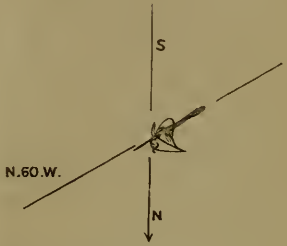


Fig. 8.

By the comparison of a number of diagrams of earth vibrations, taken simultaneously at different stations, it has been an easy matter to investigate the relative amplitudes of different vibrations. Near to the origin of a disturbance the amplitude of the normal vibrations was found to be greater than that of the transversal ones, but the former, as they progressed outwards, died out more quickly than the latter. The diminution in the period of these vibrations as they died out at a single station, or as they died out by propagation to distant stations, was also a matter of considerable importance. In connection with this subject it does not seem impossible that when we have a large earthquake, say like that of Lisbon in 1755, that the vibrational period of the disturbance may gradually be so far reduced, although its amplitude may be great, that inhabitants in distant countries may be moved backwards so slowly that the only indication of the motion would be a slow rising and falling in the waters of their lakes and ponds.

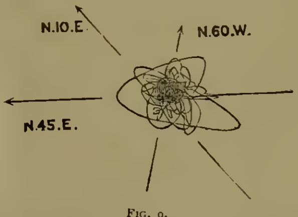


Fig. 9.

May not certain disturbances of this nature, like the *seiches* of Switzerland, usually attributed to variations in atmospheric pressure, be sometimes caused by slow oscillations of this description?

Sir William Thomson has suggested that Mr. George Darwin should employ the same reasoning to discuss these phenomena as that which he has so well employed to discuss the elastic yielding of the earth in connection with the rise and fall of tides. Sudden alterations in barometrical pressure may possibly produce earthquakes of large amplitude and slow period, similar to those here referred to, which hitherto have been passed by unnoticed. The following are examples of the various records which have been referred to.

The diagram (Fig. 5) is a tracing from a photograph of the east and west component of the earthquake of March 11, 1882, as recorded in Tokio. The regularly marked intervals represent seconds of time. For about 12 seconds before the shock there was a rapid tremulous motion. It will be observed that the westward motion of the shock is less in amplitude, and has been performed more slowly than the eastward motion. The origin of the shock was to the S.S.E. After the shock, which had a maximum amplitude of about 3·5 mm., the motion died out irregularly. Altogether the earthquake lasted about 1½ minutes. Prof. Ewing, who recorded this same disturbance at a station about a mile distant, recorded a maximum motion of 6 mm., and the duration of the disturbance could be traced over a period of about 4½ minutes.

Fig. 6 represents the normal motion of the ground produced by exploding about 2 lbs. of dynamite in a bore hole about 8 feet deep. The distance at which the seismograph was placed from the explosion was 100 feet. The intervals represent half seconds of time. The upward movement indicates motion inwards towards the origin of the disturbance.

The three diagrams (Figs. 7, 8, 9) are diagrams of actual earthquake motion, as drawn by a pendulum seismograph on stationary smoked glass plates.

Fig. 7 an earthquake at Chiba (16 miles E. of Tokio), 11.49.0 p.m., February 16, 1882. Here the motion has been simply in *one* direction, S. 35° W. Its extent is about ·9 mm.

Fig. 8 an earthquake at Chiba, December 23, 1881. Here the motion has been in at least *two* directions, N. and S., and N. 60° W. The maximum amplitude is about 1 mm.

Fig. 9 an earthquake at Tokio, 4.15.0 p.m., March 8, 1882. Here there has been motion in *several* directions. The maximum amplitude is about 2·2 mm.

Another class of seismic experiments which, although they are by no means sufficiently complete have yielded good results, are those in which time observations have formed the important features. One result of these experiments, in addition to telling us the side and locality from which earthquakes have come, has been to show that the direction in which the ground has vibrated has sometimes been at right angles to the direction in which the disturbance was being propagated. The chief results, however, have been with regard to the velocity of propagation. These may be epitomised as follows:—

1. Different earthquakes, although they have travelled across the same district, have done so with different velocities.
2. The greater the initial disturbance the greater the velocity of propagation.
3. The same disturbance is propagated with a decreasing velocity.

These results it may be remarked have received direct confirmation, both for normal and transverse motions, in experiments made by exploding charges of dynamite.

Another point which has received considerable attention has been the production of what are apparently earth currents at the time of an artificial disturbance.

A problem of local interest which has been worked at for some years has been the localisation of the origins of the shocks which from time to time disturb the eastern shores of Japan. The result of these labours has shown that the greater number of shocks have originated beneath the sea, off a coast which shows clear evidence of recent and rapid elevation.

A phenomenon which has clearly been illustrated in these investigations has been the very rapid manner in which heavy mountain ranges have completely prevented the spread of a disturbance.

By placing a large number of similar seismographs on the hills and in the valleys of a limited area, it has been quantitatively demonstrated that we may have two localities within a quarter of a mile of each other, one of which will experience at least double the amount of disturbance as the other. In some localities the hills appears to be the most affected, at others the plains are the troubled regions.

Having before us the diagram of an earthquake, and knowing its origin relatively to the locality where it was drawn, by comparing this with the diagram produced by the explosion, say, of 5 lbs. of dynamite at the distance of 100 feet, we are now enabled to calculate in pounds of dynamite or other units a value for the impulse which created the earthquake.

Not only have earthquakes been investigated, but with the help of microphones and apparatus similar to that employed by the Brothers Darwin at Cambridge, a good deal of attention has been given to the recording of earth-tremors. The results of these investigations have not as yet been sufficient to enable us to form any general laws such as those which have been formulated by Prof. Rossi and other workers in the Italian Peninsula.

A utilitarian branch of seismology has been a study of the effects which have been produced upon buildings. Walls with openings in them, which run parallel to the direction in which there is the greatest motion, appear to be more cracked than those at right angles to such directions. At the time of an earthquake existing cracks in a building have been found to open and shut. Records of these motions have been obtained by means of specially contrived indicators placed across the cracks. Other cracks which had been marked and dated at their extremities appear to have extended. The effects of placing brick chimneys with wooden houses, giving too steep a pitch to a roof, causing archways over doors and windows to meet their abutments at sharp angles, have been objects of observation. The difference in the effects produced upon buildings like those of the Japanese, which simply rest upon the surface of the ground, and those which by means of foundations are firmly attached to the soil, have yielded instructive lessons. In short it would seem that for earthquake countries the rules and formulæ used by engineers and architects require considerable modification. In England the principal elements which enter into consideration, are stresses and strains produced by gravity acting vertically. In an earthquake country we have in addition sudden stresses and strains arising from forces applied more or less horizontally.

After the lessons placed before us by the ruins which earthquakes have produced in various portions of the globe, should we undertake any great engineering work in an earthquake country, as, for instance, the Panama Canal, without first having carefully considered how best to avoid the evils arising from the sudden acquisition of momentum consequent on seismic disturbances, is for shareholders in these undertakings a financial suicide. Because earthquakes are strong the usual method to meet them is by strong construction. Still very much more than this may be done. And if we cannot prevent the destructive effects of earthquakes, observation in Japan has shown that we can at least mitigate them. This is testified by the modification in the style of buildings now adopted in Japan by all who suffered by the earthquake of February 22, 1880.

The observation of earthquakes in Japan has therefore led to results which are utilitarian as well as scientific. The description which has here been given of the work which is going on in that country is short and imperfect, many branches of seismological investigation which have been taken up has not even been referred to.

In conclusion I must draw attention to the excellent opportunities which many of those residing in Britain have for the observation of artificially produced earth tremors. By these I mean the vibrations which are produced by our railway trains, our carriages, explosions at mines and quarries, steam hammers, the falling of balls used in the breaking of castings, and other means. All of these vibrations I can state with confidence are capable of being graphically recorded, and the value of a series of such records to the practical seismologist it is hardly necessary to dilate upon.

Investigations of this description are the laboratory work of the practical seismologist, and often lead to more valuable results than those which are obtained from actual earthquakes. Actual earthquakes are produced by unknown causes, they come at unknown times, and from unknown localities. With artificially produced disturbances none of these difficulties have to be contended with, the cause and the result are before us simultaneously, and we are enabled to arrive at laws which actual earthquakes would never yield to us.

Another point to which I should like to draw attention is the study of earth movements in general. Hitherto we have only devoted our attention to the sudden and violent movements which we call earthquakes. In addition to these we have in nature movements of less amplitude called *earth tremors*. Inasmuch as we now know that these are probably a universal phenomenon, and at the same time are in every probability governed by laws simpler than those which govern earthquakes which are usually due to a complexity of causes, it certainly devolves upon us to establish the necessary means for their investigation. From the little we have learnt about earth tremors it is not unlikely that they may be to our continents what tides are to our oceans, phenomena which are regular and law abiding, and not like the earthquakes, which may be compared to the storms of the ocean.

In addition to these motions of small amplitude we have many reasons for believing in the existence of motions of our ground of great amplitude, but so slow in period that hitherto they have been overlooked.

In order to complete the study of earth motions we have to add to seismology the study of earth tremors and what might be called earth pulsations.

As we have done so much for our skies, for our atmosphere, and for our waters, we can surely do a little towards the investigation of the movements of the earth on which we live.

Although these latter remarks have no direct connection with the work which has been accomplished in Japan, they are nevertheless an outcome of such work, and if they tend in any way to draw attention to a much neglected study, an object will have been attained greater than any which could be hoped for by diffusing a knowledge of the labours of those who dwell at our Antipodes.

JOHN MILNE

THE LATE PROFESSOR BALFOUR

THE meeting held last Saturday to establish a memorial to the late Prof. Balfour was very largely attended by all grades in the University, and among nonresidents by Professors Huxley, H. J. S. Smith, A. W. Williamson, W. K. Parker, Ray Lankester, H. N. Moseley, and A. M. Marshall and Mr. George Griffith, of Harrow. The president of the Royal Society would have been present but for his recent accident. The speakers, including most of those mentioned above, and Professors Paget, Humphry, Newton, and Westcott, bore unanimous testimony to the high regard and affection in which the lamented professor was held, to the original work he had accomplished, and the high promise of his life, and to the energy and success of his teaching. Dr. Paget referred to Balfour's having abandoned his favourite pastime of deer-stalking in order not to inflict unnecessary suffering upon harmless animals, and his having taken up instead that of Alpine climbing, in which he met his death. Any memorial to him would, he hoped, do something to perpetuate the spirit in which his scientific achievements had been accomplished, which placed him beside such men as Miller, Sedgwick, and Clerk Maxwell. Mr. A. Sedgwick, late demonstrator with Balfour, spoke of the growth of the class in seven years from ten to ninety students, and of the crushing nature of his loss to the school he had attracted around him, for his personal intercourse and counsel was of the extremest value.

Prof. Huxley, in proposing "That the memorial take the form of a fund, to be called the Balfour Fund, for the promotion of research in biology, especially animal morphology," said that after the addresses they had listened to with painful interest, it would be superfluous for him to add his personal testimony to the remarkable sagacity and the remarkable characteristics of Prof. Balfour. It was no exaggeration to say that in his eyes and to many of his age he seemed to be like Lycidas, of whom Milton wrote, "who died in his prime and hath not left his peer." The remarkable capacity he exhibited was developed by a multitude of surrounding circumstances. He was happy to say that he personally had contributed, amid a multitude of more powerful forces, to that which led to the development of his great powers. When Balfour was a young man, a paper he had written while at Harrow School was sent to him for his judgment, and again when Balfour was a candidate for a Fellowship at Trinity College, he was one of the examiners. "Amid many of my faults and failings during a long life," said Prof. Huxley, "I do not reproach myself for neglecting to recognise the capacity of the friend we have lost, both in the paper written while at Harrow and during the examination for the Fellowship at Trinity." He would draw attention to two words in the resolution he proposed—viz., research and morphology. The late Professor distinguished himself in both these directions. In former days men were content with being learned, but now we must not only know what is known, but help to extend the bounds of knowledge. This Balfour did, and his title as an eminent researcher was undoubted. With regard to morphology, it was a science until recently only known as a field of wide speculation of German philosophers. It was now a new learning, a great system of doctrine, established by an enormous mass of carefully co-ordinated facts. Three things were requisite to develop this new science:—1. Mastery of practical methods. 2. Accuracy of observation. 3. Vividness of imagination. He had never met any one more marvellously gifted with these three great qualities than Prof. Balfour. If his unshrinking modesty could have foretold this meeting, there would not be any form of memorial more entirely grateful to his feelings than the one proposed. A monument in stone or brass would be inappropriate; but to establish through this fund a perennial spring of activity in the direction of the study he pursued would be a more lasting and perfect memorial. And they might think of him in the concluding words of "Lycidas":—"Henceforth thou art the genius of the shore, In thy large recompense, and shalt be good To all that wander in that perilous flood"

Prof. Newton proposed "That the proceeds of the fund be applied (1) to establish a studentship, the holder of which shall devote himself to original research in biology, especially animal morphology; (2) to further, by occasional grants of money, original research in the same subject." He said that the room and the building in which they were assembled reminded him that he felt and entered for the first time into the full meaning of the Poet Laureate's words—"But O! for the touch of a vanish'd hand And the sound of a voice that is still." With reference to an allusion of Mr. Sedgwick, he said he should always consider it to be one of the brightest episodes of his career that, having found in Balfour a young man capable of giving instruction, he had afforded him facilities. The late Professor was not only an instructor but a student, and no one ever remained so much a student."

Prof. Williamson proposed "That a committee be appointed to collect subscriptions and to draw up conditions under which, with the sanction of the subscribers at a future meeting, the fund shall be offered to the University."

Dr. Michael Foster proposed the following resolution:—"That the Committee be instructed—(1) that the value of the studentship be not less than 200*l*. a year; (2) that while it is desirable that the studentship should be in some way closely connected with this University, persons other than members of this University shall be eligible to it; (3) that it be not given away by competitive examination; (4) that in framing regulations both for the conduct of the student and the award of occasional grants, the primary object of the fund—namely, the furtherance of original research, be closely adhered to." He said he thought the above instructions to the Committee did not need any defence. The object of the memorial was not to keep Prof. Balfour's memory alive, for his works would do that, but to connect his name with some useful thing. The idea in fixing the value of the studentship at 200*l*. was that such a sum would be just sufficient to attract men led by enthusiasm to turn their attention to research, while it would be insufficient to induce persons to accept it as a competency. He thought it right not to restrict the studentship to members of the University, for they desired to attract talent from all parts of the country, while he considered that it was a proper condition not to throw it open to a competitive examination, for the studentship was not intended as a reward for past work or an acknowledgment of merit, but to encourage men of promise to undertake research.

An influential committee was appointed to collect subscriptions and draw up detailed conditions under which, after a future meeting of subscribers, the fund may be offered to the University. Mr. J. W. Clark, M.A., 1, Scroop Terrace, and Mr. A. Sedgwick, M.A., Trinity College, Cambridge, were appointed secretaries of the committee, the former to act as treasurer. The fund starts well, with the munificent contribution of 3000*l*. from the family of the late Prof. Balfour, and to 1000*l*. which had been left by the deceased to Dr. Michael Foster to be applied according to his discretion for the promotion of biology; nearly 1000*l*. was subscribed in the room or shortly afterwards.

DR. THWAITES

GEORGE HENRY KENDRICK THWAITES, whose death was recorded in a recent number of NATURE, was a well-known member of the older generation of British botanists. I do not know the exact date or place of his birth, but suppose it to have been in 1811. In his early life he followed the profession of Notary Public at Bristol, and apparently had a hard struggle to support and educate numerous younger brothers and sisters. He had a natural passion for botanical studies which he cultivated to such good purpose as to obtain the appointment of Lecturer on Botany and Vegetable Physiology at the School of Medicine at Bristol. He was no less ardent as an entomologist, and throughout his life collected assiduously; some of his earliest papers are on entomological subjects. His principal published work has, however, always been botanical. Till he left England he was mostly occupied with microscopical investigations, and what he published of these were like all that he did later—excellent specimens of careful and intelligent observation. His paper "On the Cell-membrane of plants" (1846) which established many interesting and at that time novel points, received a good deal of attention. Amongst other things it apparently gave the first accurate interpretation of the mucous investment of the cells of many *Palmelleæ*, *Nostochineæ*, and *Diatomaceæ;* Thwaites was able to show clearly that this was the product of the gelatinisation of the cell-walls. His capital discovery, however, was that of Conjugation in the *Diatomaceæ*. This he observed in *Eunotia turgida*, and the paper describing it bears the date May 11, 1847, and was published in the *Annals and Magazine of Natural History*. It was, as Thwaites himself remarked, "a discovery which is valuable as proving that a relationship of affinity as well as of analogy exists between the *Diatomaceæ* and the *Desmideæ* and *Conjugatæ*, and will help to settle the question as to whether the former are to be referred to the animal or the vegetable kingdom." I have been told nevertheless that when this important discovery was communicated to the British Association at Oxford, it was received with but little attention.

The present director of the Royal Gardens, Kew, then Dr. Hooker, was about this time attached to the Geological Survey. At the instance of Sir Henry de la Bêche he was engaged in the Bristol Coal Field, endeavouring to ascertain whether any definite relation could be traced between the superficial flora and the underlying rocks. This brought him in contact with Dr. Thwaites, who was, notwithstanding his professional pursuits, in the habit of spending the early hours of the morning in teaching himself the practical details of gardening in the Durdham Down nurseries. It was probably this circumstance which brought under his notice the curious instance of hybridity in a Fuchsia, which so much excited the interest of Mr. Darwin, and has often been referred to. A seed of *F. coccinea* fertilised by *F. fulgens* contained two embryos. These were extremely different in appearance and character, though both resembled other hybrids of the same parentage produced at the same time. What was still more remarkable, was that they were closely coherent below the two pairs of cotyledon-leaves into a single cylindrical stem.

In 1847 Thwaites was an unsuccessful candidate for a chair of botany in one of the newly founded Queen's Colleges in Ireland. His combined scientific and practical knowledge, however, indicated his fitness for a botanical post, and on the death of Dr. Gardner, he was appointed in June, 1849, Director of the Royal Botanic Garden, Peradeniya, Ceylon, on the recommendation of Sir William Hooker. He never returned to this country, and from the first threw himself into the duties of his post with great fervour; under his management Peradeniya became perhaps the most beautiful tropical garden in the world. He continued the labours of his predecessors in investigating the very peculiar flora of the island with great success, and, between the years 1858-64, issued, in parts, the "Enumeratio plantarum Zeylaniæ." This was at the time of its publication the first complete account on modern lines of any definitely-circumscribed tropical flora. The want of affinity which the flora thus worked out was seen to have to the general vegetation of the contiguous peninsula of Hindostan and its marked relationship to that of the Malayan region established facts of the greatest significance in the study of geographical distribution. A passage from the preface (1864) is worth quoting, as showing that Thwaites was one of the earliest English naturalists to give his adhesion to the Darwinian theory:—

"These forms or varieties would probably be viewed by some botanists in the light of distinct, though closely-allied species, and they occupy, in fact, that debatable ground the difficulties and perplexities of which the practical naturalist alone knows, and which in the opinion of many (and I may include myself amongst the number) are only to be got rid of by the adoption of the views enunciated by Mr. Darwin as regards the relationship of allied forms or species by descent from a common ancestor."

Besides the "Enumeratio," Thwaites published subsequently a few papers on detailed points in Ceylon botany.

His tenure of office was associated with some of the most important developments of the Ceylon planting industry. In 1861 and subsequent years he took an active part in the operations undertaken by the Government of India, in concert with the Royal Gardens, Kew, for the introduction of Cinchona into the East. From the first the enterprise succeeded in Ceylon beyond expectation, and in 1869 the first ton of bark grown in the island was sent to England for sale. In 1864 he began to urge the cultivation of tea, and in 1868 a sample, manufactured in Ceylon, was sent to this country. Cocoa was similarly brought forward in 1867, and it now bids fair to be one of the most important of Ceylon staples. Liberian coffee was introduced from Kew in 1873. In 1876 the plants of Para, Ceara, and Central American india-rubber plants, obtained for the Indian Government, were sent from Kew, where they had been propagated, to Dr. Thwaites' charge in Ceylon, which was made the depôt, for their subsequent distribution to India.

During the later years of his life Dr. Thwaites had been in weakly health, and lived latterly a retired and extremely abstemious life. But his singularly refined and cultivated mind always gave him a position of distinction in Ceylon society, and he enjoyed the esteem and personal friendship of successive governors. He became a Fellow of the Linnean Society in 1854, and of the Royal Society in 1865; and in 1878 the Crown conferred upon him the Companionship of St. Michael and St. George, in recognition of his long services. Two years afterwards he retired, and took up his abode near Kandy, being unable to persuade himself to leave the island where so much of his life had been continuously spent. He died on September 11, and was followed to the grave on the following day by a large assemblage and the members of the Peradeniya Garden Staff, including the coolie labourers.

W. T. T. D.

ELEVATION OF THE SIERRA MADRE MOUNTAINS

DURING the past summer, in travelling across the Sierra Madre Mountains from Parral in the southern part of the State of Chihuahua, Mexico, to the mining town of Guadalupe y Calvo, on the Pacific slope about one hundred and fifty miles from the Gulf of California, some observations were taken with a small pocket aneroid barometer with thermometer attached, which may be of interest to the readers of NATURE. Both barometer and thermometer had been carefully compared with the standard instruments in Vanderbilt University and the proper corrections made.

Starting from Parral, or Hidalgo as it is generally named on the maps, the road leads in a south-westwardly direction to the small mining town of Santa Barbara, at the foot of the Sierra Madre range. From this point there is no road, but merely a trail running westwardly through the small villages of Providentia, Cerro Prieta, and Piedra Larga—the two former in Durango—to the old mining town of Guadalupe y Calvo, a distance of about eighty Mexican leagues or two hundred English miles. The journey can only be made on mules, or horses accustomed to mountain travel, as there are no roads, and the trail passes over several precipitous mountains. The distances, as near as could be ascertained, are about as follows:—

	Leagues.
Parral to Santa Barbara	7
Santa Barbara to Providentia	7
Providentia to Cerro Prieta	18
Cerro Prieta to Piedra Larga	26
Piedra Larga to Guadalupe y Calvo	22

The heights going westward as determined by the barometer at the several stations mentioned, are as follows:—

	Feet.
Parral	5,880
Santa Barbara	6,490
1st Mountain	8,670
Providentia	6,850
2nd Mountain	10,220
Cerro Prieta	6,720
3rd Mountain	8,760
Cave	9,270
Valley of Rio Verde	9,110
4th Mountain	9,440
5th ,, ...	9,350
Piedra Larga	8,010
6th Mountain	9,470
7th ,, ...	9,260
Guadalupe y Calvo	7,500

The temperature in the mountains—July 10 to 31—ranged from 58° to 85°. During five days in Guadalupe y Calvo—July 20 to 25—the temperature was taken at 6 a.m., 12 a.m., and 6 p.m., and found to range from 59° to 68°. On two days—July 21 and 22—it was 65° at the time of each observation. The rainy season begins about the middle of June and extends to the 1st or middle of September. The amount of rain that falls increases towards the west. The mountains run generally S.S.E. and N.N.W., and are covered with fine timber, consisting mainly of yellow pine.

Outside of the villages mentioned there are no inhabitants except a few Indians, descendants of the Aztecs, who live chiefly in caves and cultivate small patches of corn, beans, and pepper, and have small herds of cattle. These Indians are peaceable. The Apaches once roamed through these mountains, but of late years their depredations are confined to Middle and Northern Chihuahua and Sonova.

N. T. LUPTON

Vanderbilt University, Nashville, Tenn., October 3

NOTES

MR. M. A. LAWSON, M.A., F.L.S., having been appointed Superintendent of the Government Cinchona Plantations (Madras), the Professorship of Botany at Oxford will shortly be vacant.

ALTHOUGH they have M. Cochery as their common president, the two Electrical Congresses now sitting in Paris have separate sittings, as well as separate ends. The greater number of Governments have appointed separate delegates for each. The programme for the Congress on Electric Units was already published at the end of the session of the Congress of Electricians, and adopted by them. The consequence is that the committees were established beforehand, and that some Governments, as Belgium and Italy, appointed special delegates for each committee. The total number of delegates is sixty-two. The German Empire, having the exclusive right of representing the central Government in foreign parts, no delegate has been appointed either by Bavaria or Saxony; but amongst the five German delegates we find the name of Dr. Kohlrausch, Professor at the Bavarian University of Wurzburg. After having appointed M. Cochery as president, the Congress appointed a secretariat composed of two French officials; four others, belonging to the French Administration, have been appointed as *secrétaires rédacteurs*. The records of the Congress will be published under their authority. The members of each of the several committees have appointed their president or a president and secretary, and will communicate the results of their work at general meetings. It is probable that scientific committees will be established, and that the Congress will dissolve after having appointed them, or possibly adjourn to a future occasion. The same routine will be followed as on the occasion of the Congress of Electricians, of which this Congress must be considered as the sequel. The funds for conducting the experiments have been voted, as we reported, by the French Houses of Parliament, to the extent of 90,000 francs, but practically to any amount.

THE Congress on Cable Protection may be said to have been established in furtherance of a deliberation taken unanimously by the Congress of Electricians, but this deliberation was not acknowledged as binding by the French Government, and was not proclaimed at the time. The consequence is that the French Foreign Office caused a special programme to be drawn out after having consulted the Postal Telegraph Office and foreign governments. The schedule for the direction of the deliberation is divided into three parts:—1. The protection of cables. 2. The protection of shipping laying cables. 3. The right of property in the bottom of the sea, and rules for laying cross or parallel lines and repairing them. Although a certain number of delegates sit in both Congresses, the majority of them belong to the legal or maritime profession. The two Congresses will hold general meetings this week, and at the end of each the Minister of Postal Telegraphy will hold a levée at his official residence. The names of the British delegates are the following:—Sir William Thomson, Prof. Carey Forster, Lord Rayleigh, Prof. Fleeming Jenkin, Dr. Hopkinson, F.R.S. Cable Protection:—Mr. Kennedy, Mr. Patley, Mr. Trevor; Mr. Farnall of the Foreign Office will act as the Secretary of the British delegation.

IN a postscript to Mr. G. B. Bennett's letter to Sir J. H. Lefroy on the comet (see p. 623), the writer says:—"Since closing my letter, I have been informed that Miss North has left Wynberg for the interior. She is bent on depicting the Welwitschia. She will have to go into the Damara country to find one. I can scarcely believe that she has gone to such a distance."

A DESPATCH from Montreal, dated October 9, states that the Montreal City Council has been officially notified by the Secretary of State of the Dominion that the British Association will meet there in 1884, and has been asked that due arrangements be made.

THE French Minister of Public Instruction presided on October 11 at the inaugural sitting of a new commission created by M. Ferry, to determine the best measures for the hygiene of school children. The number of members of this commission is forty-five, amongst whom are eight females, either professional teachers or connected with the efforts made recently for promoting female education in France.

ON October 10 the Swiss Universities celebrated the fiftieth anniversary of the beginning of the scientific career of Dr. Valentin. The five Swiss Universities and no less than twenty foreign ones sent him diplomas of honour and congratulations. The health of the eminent physiologist is, however, so bad that he was confined to bed, at Geneva.

THE first provincial dinner of the Institute of Chemistry was held at the Great Western Hotel, Birmingham, on Friday, the 20th inst., and was numerously attended, both by members residing in and around this busy centre of chemical industry and by members from London. In replying to the toast of the evening, "Success to the Institute," the President, Prof. Abel, briefly traced its history. It was established to supply the want, keenly felt by the chemical profession, of an organisation to protect their interests. Its fundamental objects were the promotion of a thorough study of chemistry and the adoption of whatever measures might be necessary to advance the interests of the profession. A suitable course of training had been laid down after careful consideration and the attainment of the grade of Member and Associate was gradually coming to be regarded as a proof of fitness for election to technical, professional, or official appointments. On Friday and Saturday the members visited Earl Dudley's Iron Works, Messrs. Chance's Alkali and Glass Works, the Mint, Gas Works, &c.

MR. THOMAS COATS, of Ferguslie, Paisley, has handed over to the keeping of the Paisley Philosophical Institute an observatory erected on Oakshaw Hill, the total value of the gift being 12,000*l*.

A SUBSCRIPTION towards the English Darwin memorial has been opened in Stockholm. The Swedish press warmly supports the same, pointing out that it is not money which England asks for, but the tribute of a cultivated nation to one of her greatest *savants*.

A LETTER dated September 22 has been received by the promoter of the Danish Polar Expedition, Herr Gamel, from Lieut. Hovgaard, in which he states that the *Dijmphna* is frozen in near Novaya Zembla, but he hoped to get free during the equinoctial gales and reach the Jenisei. All was well on board.

THE Captain-General of the Philippine Islands telegraphs from Manila, October 21, that a tremendous hurricane had almost entirely destroyed that town. In less than an hour from its commencement not a single native house and not a single wooden house was left standing. Almost all the stone buildings, even those having iron rafters, were unroofed and made uninhabitable. Comparatively few casualties had taken place among the population. In a later telegram the Captain-General says that the authorities of Balacan and the interior of the island report a similar destruction as caused by the hurricane, and fifteen thousand more persons are houseless. Singularly enough, on the first day after the hurricane not a single case of cholera occurred in Manila or the island. The tornado not only swept over the entire Archipelago, but was felt many hundred miles out at sea, especially to the south and west. It is believed that more lives have been lost by shipwreck than on land.

AN interesting experiment has been made in Paris by M. Mangin, a member of the Académie d'Aérostation. A small balloon, measuring about 100 cubic feet, and filled with pure hydrogen, was sent up, being held captive by a rope containing two copper wires. A Swan incandescent light having been placed in the gas and attached to the top of the balloon, was lighted, and the whole aërial machine, which was quite translucent, was splendidly illuminated. It was shown by systematic interruptions that the dots and dashes of the Morse system could be imitated for giving military signals at a great distance.

NEWS from Verona states that the subterranean shocks continue. Houses have been destroyed by earthquakes at Cassone, Brescia, and Verona, and between Campiore and Forbefice a landslip occurred. A severe earthquake was experienced at Silchar, India, and in other districts in a lesser degree on the 13th inst.

THE Corporation of the town of Sheffield having resolved to apply to Parliament, under the Electric Lighting Act, for extensive powers for the illumination of the borough by electricity, not only in the streets and public buildings, but also in the private houses, Mr. Conrad W. Cooke, who has been appointed consulting engineer to the Corporation, has been instructed to prepare and report upon a scheme to be adopted by the Corporation.

MR. T. V. HOLMES, F.G.S., M.A.I., will read a paper on "Dene-Holes," at the meeting of the Essex Field Club to be held at 3, St. John's Terrace, Buckhurst Hill, at seven o'clock on Saturday next, the 28th inst. The paper and the discussion thereon will have special reference to the Club's projected explorations at Grays, Purfleet, and Tilbury. Archæologists and others interested in these mysterious relics are invited to attend the meeting.

THE *New Zealand Times* of September 1 contains an account of the presentation of degrees at Wellington in connection with the New Zealand University examinations. The chair was occupied by Dr. Hector, Vice-Chancellor, who said it had been decided by the Synod of the New Zealand University that the presentation of degrees should in future be made in public. The Chancellor being unable to be present, the duty of presenting the degrees had been deputed to him. The New Zealand University had been in operation since 1870, and there had been 155 graduates, of whom forty-nine had taken degrees. This might appear a small result, but the object of the University was to raise the standard of education, and this had been done. The system of scholarships had been continued with the University course, and a large portion of the funds had been spent in this way. For some time past the examiners had been appointed in London, and the degrees granted had a value, in the eyes of the outer world, equal to those granted by the London University. Owing to its charter, the New Zealand University could not grant degrees for science, but there was every prospect that the barrier would soon be removed, Dr. Hector then referred to the disaffiliation of Wellington College, which has been converted into a high school for secondary education. The step, he said, was necessary in order that they might get a University College.

A CURIOUS project in the way of recreation, by M. Joyeux, is published in *La Nature*. Suppose a large circular wooden chamber, lit from above, but giving no view of outer objects from within, and rotated smoothly and rapidly on a vertical axis. A person standing in it would have to bend his body towards the centre, by reason of centrifugal force, and the more so the further he might be from the centre and the higher the speed. M. Joyeux supposes he would be subject to the illusion that the floor was inclined upwards from his position to the centre; if he had to place himself at an angle of 45°, the floor would seem inclined at this angle, and a person standing in the corresponding place on the opposite side would seem horizontal, for he, too, would have to make an angle of 45°. Only at the centre would the floor seem horizontal; and if a number of persons were in the chamber, it is only there one would see them in their real positions. A person walking round the circumference would seem to be at the outside of the base of a cone, which turned under him. To facilitate the position of persons, M. Joyeux would make the floor, not horizontal, but inclining upwards at a certain distance from the centre. M. Tissandier does not feel certain that the illusions described would actually occur, but regards the scheme as an attractive curiosity. The apparatus is named a *plagioscope*.

IN a recent paper to the Belgian Academy, M. van der Mensbrugghe seeks to explain the calming influence of oil on rough water, in accordance with the principle he has laid down, that whenever a liquid mass in motion acquires rapidly a free surface, more or less, there is developed a growing quantity of potential energy at the expense of the kinetic energy of the mass; and reciprocally to a rapid diminution of free surface corresponds always an increase of kinetic energy. Oil hinders the successive superposition of liquid layers, and so, the increase of the kinetic energy of the liquid mass. Floating bodies of various kinds (branches, sea-weed, ice-crystals, &c.) have a like action; immediately after the gliding of a very small number of liquid layers over them they obey the thrust that brings them to the surface, and so render impossible the increase of kinetic energy corresponding to loss of potential energy of a large number of superposed layers.

IT has been observed by M. Fredericq (*Bull. Belg. Acad.*) that the blood of crabs and other crustaceans at Ostend has the same strong and bitter taste as the sea-water, and proves to have the same saline constitution. Crabs in brackish water, on the other hand, have a less salt blood, and the crayfish of rivers have very little of soluble salts in their blood. An exchange of salts seems to take place, in these animals, between the blood and the outer medium, producing approximate equilibrium of chemical composition. This probably occurs through the respiratory organ, and is according to the simple laws of diffusion. On the other hand, the blood of sea-fishes has an entirely different saline composition from that of the water; it is more or less isolated, presenting herein an evident superiority over the invertebrates referred to.

A USEFUL complement to M. Marey's recent method of applying photography to physiological experiments (in which a bright body moving before a dark screen is photographed several times in quick succession) has been supplied by M. Ch. Petit in a process which he calls *similigravure;* whereby the photographic picture is easily reproduced for insertion in a text. Two specimens are given in *Comptes Rendus* of October 2; one of them, showing the successive attitudes of a man marching at the parade step, the other, those of a white horse, with rider, leaping over an obstacle. The process is not described; but those pictures present at a glance (M. Marey points out) much that is instructive, showing, in the former case, *e.g.* the position of different parts of the body during the step (which was executed in 6·10ths of a second).

IN the October number of *Petermann's Mittheilungen* are two papers of scientific interest: one on the Geology of the Balkan Peninsula, with map, by Prof. Franz Toula; and the other on the Distribution of the Aurora Borealis in the United States, by Prof. H. Fritz.

M. LISCH, inspector of historic monuments, has recently discovered a whole Gallo-Roman town in the environs of Poitiers. It includes a temple, 14 m. long, and with 70 m. of facade, a thermal establishment covering 2 hectares, and still possessing its piscinæ, hypocausts, pipes, flagging, &c., a theatre, the stage of which is 99 m. in width; entire streets, and more than 7 hectares of buildings (the excavations are not yet finished). "It is," he says, "a small Pompeii in the centre of France." The sculptures are in the best style, and thought to date from the second century.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii* ♂) from South Africa, presented by Mr. H. T. Hardcastle; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Miss Katie Thomason; a Common Paradoxure (*Paradoxurus typus*) from India, presented by Mr. J. Wood; a Naked-eared Deer (*Cariacus gymnotis* ♀) from Ecuador, presented by Miss Lake; an Oyster-catcher (*Hæmatopus ostragelus*), British, presented by Mr. W. R. Temple; a Maholi Galago (*Galago maholi*) from South Africa, deposited; a Ruff (*Machetes pugnax*), a Redshank (*Totanus calidris*), British, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMET 1882 *b* (FINLAY, SEPTEMBER 8).—The following ephemeris is deduced from the same elements as that given last week :—

At 18h. Greenwich M.T.

	R.A.	N.P.D.	Log. distance from Earth.	Log. distance from Sun.
	h. m.	° ′		
Nov. 2	9 52·7	110 23	0·1700	0·1509
6	9 45·8	111 47	0·1716	0·1749
10	9 38·3	113 9	0·1728	0·1970
14	9 30·1	114 27	0·1739	0·2176
18	9 21·1	115 40	0·1751	0·2368
22	9 11·3	116 47	0·1766	0·2549

At the time we write a sufficient number of observations before perihelion passage to allow of a reliable determination of the orbit prior to the close approach to the sun, is not available.

By the way it strikes us it is about time that M. Crul's name was disassociated from this comet; if personal names are to be attached to naked-eye comets, a practice which to say the least, is inconvenient, Mr. Finlay, so far as is known at present, has the prior claim. The system generally adopted for some years, of assigning letters, *a*, *b*, *c*, &c., to comets discovered in a particular year, until their order of perihelion passage is definitely known, was, we think, an advantageous one, and its discontinuance in some quarters is a retrograde step.

COMET 1882 *c* (Barnard, September 10).—From the first observation at Harvard College on September 14, and observations by Prof. Millosevich, at the Collegio Romano in Rome, on September 22 and October 7, Mr. Hind has calculated the following elements of this comet:—

Perihelion passage 1882, November 13·0067 G.M.T.

	° ′
Longitude of perihelion	354 47·6
,, ascending node	249 8·9
Inclination	83 43·1
Logarithm of perihelion distance ...	9·97998

Motion—retrograde.

From these elements it appears that the comet will be observable in the southern hemisphere for some weeks after it descends below the horizon in Europe. At perihelion passage on November 13, its right ascension will be about 199°·4, with 66½° south declination, which places it near η in the constellation Musca; on December 10 it will be situate between the stars γ and η in Ara, with 58° declination, and an intensity of light one-third greater than at the first Harvard observation, and on January 9 its place will be near ε Telescopii, with one-half the intensity of light of September 14.

PONS' COMET OF 1812.—MM. Schulhof and Bossert have published a continuation of their extensive ephemerides to facilitate the search for this comet from October 28 to February 4, and for equal intervals of true anomaly from −97° 30′ to +82° 30′. By their new and complete discussion of the observations, including a series by Blanpain at Marseilles, which they discovered in the original, and which they consider the best of all, the most probable elements in 1812 were found to be as follows:—

Perihelion passage, 1812, September 15·33210 Paris M.T.

	° ′ ″	
Longitude of perihelion	92 19 48·2	Mean Equinox, 1812·0
,, ascending node	253 0 43·7	
Inclination	73 57 35·8	
Excentricity	0·9555842	
Logarithm of perihelion distance ...	9·8904903	

The corresponding period is 73·18 years, but the probable error of this period of revolution is ± 4·5 years. Notwithstanding this large amount of uncertainty, MM. Schulhof and Bossert have calculated the effect of the action of the planets Jupiter, Saturn, Uranus, and Neptune during the actual revolution, and find the most likely epoch of the next perihelion passage to be 1884, September 3·65, M.T. at Paris.

THE TRANSIT OF VENUS.—Mr. Marth, who has charge of the proposed station at Montague Road, Cape Colony, left for Cape Town in Messrs. Currie and Co.'s mail steamship *Conway Castle* on the 13th inst., and Mr. Talmage, of Mr. J. Gurney Barclay's observatory at Leyton, proceeded in the R. M. steamship *Nile* on the 17th for Barbados, with Lieut. Thomson, R.A., as his colleague. Mr. J. Plummer, in charge of Col. Tomline's observatory at Orwell Park, Ipswich, with Lieut. Neate, R.N., have also left for New York, on their way to Bermuda. All the British expeditions are therefore *en route*.

Brazil will furnish four stations, with similar instrumental equipment, including equatorials of 6 inches aperture. M. Cruls proceeds to a point in the Straits of Magellan, and Baron de Jeffé, of the Brazilian Navy, to St. Thomas. The other stations will be Pernambuco, and the Imperial Observatory at Rio Janeiro. M. Faye, who made a communication to the Paris Academy of Sciences on the 16th inst., in the name of the Emperor of Brazil, who takes a lively personal interest in his observatory, mentions that it is in contemplation to effect a chronometric connection of the station in the Straits of Magellan with Montevideo, an important undertaking, as viewed with reference to the telegraphic determination which the Board of Longitudes is about to execute across the American continent, from Montevideo or Buenos Ayres, to Santiago and Lima.

A SPECTROSCOPIC STUDY OF CHLOROPHYLL[1]

THE study of chlorophyll has great fascination; it also has its difficulties. We did not propose adding to the many elaborate attempts to isolate and purify this body; but the beauty and definite character of the spectrum which it gives induced us to try whether some insight into its character and constitution could not be obtained from the study of the spectroscopic changes which it can be made to undergo; and as one of us has already shown that in the case of the cobalt salts, the spectroscope enables us to follow many chemical changes, we thought that it might be possible to interpret the spectroscopic changes of chlorophyll, and so gain some knowledge of the properties and nature of this body.

The extraction of the green colouring matter from leaves was effected in most cases by breaking up the leaves in a mortar with a mixture of two parts of alcohol and one of ether. The colour of the liquid thus obtained is of a dark green, varying in shade according to the nature of the leaves used, and the solution always has the well-known red fluorescence. This liquid, when examined spectroscopically, gives what is known as the chlorophyll spectrum. According to Krauss, it consists of seven bands; the three at the most refrangible end of the spectrum are difficult, as Krauss says, to observe, and with our source of light, a gas-flame, we could see in an ordinary chlorophyll solution little or nothing of them; but under special circumstances, which will be described further on, the least refrangible of the three becomes very visible. We have confined our observations principally to the four least refrangible bands. Other solvents, such as chloroform, disulphide of carbon, benzene, &c., were used occasionally; they give a similar spectrum, but in most cases they do not dissolve the colouring matter so readily as alcohol and ether do. The ethereal solution appears always to give a clearer and more brilliant spectrum than the alcoholic solution. Fig. 1 shows the spectrum of the solution obtained as above described from the majority of the leaves we have examined.

Among common outdoor plants, the vine and the Virginian creeper may be cited as apparent exceptions, giving a different spectrum. (Fig. 2.) The second band in this case has moved towards the more refrangible end of the spectrum, the band from 589 to 573 has disappeared, and now there is a very marked band from 545 to 532. The cause of this change in the spectrum we shall explain further on.

Fig. 1 then, as far as it goes, represents the spectrum given by the alcohol and ether extract of most leaves. It is important at once to give a definite meaning to the term chlorophyll, and we would therefore state that we mean by it the body or bodies capable of giving this particular spectrum, and of course we found our conclusions on the assumption that a particular absorption-spectrum is a complete identification of a substance.

As is well known, the exact position of these bands alters with the solvent used; in all cases, when no mention is made to the contrary, a mixture of alcohol and ether is the solvent we have used. Apparently the statement that the higher the specific gravity of the solvent, the nearer are the bands to the red end of the spectrum, is not in all cases true, for we find that the chlorophyll bands are nearer to the red in carbon disulphide than in chloroform. All our observations have been made with a Dasaga's spectroscope having a single heavy glass prism, and the position of the bands is given in millionths of a meter, reduced from the observations by graphical interpolation. Capt. Abney has also been kind enough to take photographs of the different spectra, and these agree with our eye observations. They also prove that there are no bands in the ultra-red.

The first point we would note with regard to chlorophyll is

---

[1] By W. J. Russell, Ph.D., F.R.S., and W. Lapraik, F C.S.

that, as far as our experiments go—and we have now tried a large number of different leaves—although there are apparent exceptions, this particular substance we call chlorophyll exists in all green leaves.

If thinner and thinner strata, or more and more dilute solutions of the same thickness be examined, the fainter bands are seen gradually to fade out, and what is of importance, the dominant band, the last to disappear, thins out to a band from 670 to 660.

Passing over a large number of experiments on other points, we shall limit our present communication as far as possible to an account of the action of acids and alkalis on this so-called chlorophyll.

It is a body exceedingly sensitive to the action of acids. If for instance a mere trace of hydrochloric acid gas be introduced into the air of a test-tube containing a chlorophyll-solution, on shaking the tube, the 628 band will be found to have moved slightly towards the blue, and the next band to have become fainter. This action of the acid, specially with regard to the 628 band, is very remarkable; the addition of acid gradually causes this band to move bodily towards the blue, till it reaches 611—599. So constant and complete is this action, that the position of the band is an indication up to a certain amount of the quantity of acid present. On adding a little more hydrochloric acid gas to the air of the test tube, and again shaking, this second band will be found to have moved from 615 to 596, the 589—573 band will have disappeared, and the other band at 545—532 will remain unmoved, but will have become much darker. On still further increasing the amount of acid, the second band comes to 611—589, and now a new band appears from 573—558, and the band at 545—532 has also again increased in intensity. Further, the blue end of the spectrum has considerably opened. This spectrum, Fig. 3, is permanent, for on adding more acid, even a large amount of liquid acid, no further alteration takes place. The action of hydrochloric acid on chlorophyll appears then to be very definite, and is well shown by the two drawings, Figs. 2 and 3, which represent two well-marked stages; in the first the movement of the 628 band and the disappearance of the 589 band, the other two bands remaining unaltered in position; in the second (Fig. 3) the 628 band has moved to its furthest extent, and a new band has appeared at 573—558, the most and least refrangible of the four bands remaining still unaltered in position.

We have described in detail these spectra, for they have great interest and importance, owing to the fact that these changes do not arise from the formation of any chlorine-compound, but are produced by the action of the hydrochloric acid simply as an acid. Substitute any strong acid, sulphuric, nitric, &c., for the hydrochloric acid, and exactly the same changes will occur. Use a weak acid, an organic acid, such as tartaric, citric, oxalic, &c., and the action does not go beyond the first stage (Fig. 2). Carbonic acid is without action on the chlorophyll.

There is also another way in which the same changes may be brought about without the presence of acid, namely, by the application of heat. If, for instance, the solution of chlorophyll be evaporated to dryness on a water-bath at a temperature of 80° or above, then on redissolution it will be found to have changed and to give no longer the original, but the second spectrum. Let the evaporation take place at ordinary temperatures in a current of air, or under the air-pump, then, on at once redissolving the residue, no change will have occurred; if, however, after the evaporation, the dry mass be kept for a short time, it will change even at ordinary temperatures. Further, if the alcoholic solution be diluted with water, and then boiled, the body giving spectrum No. 2 is formed; and the addition of certain salts, such as mercuric chloride, ferric chloride, &c., causes a similar change. Alum precipitates the colouring matter, and if the precipitate be collected, washed, and dried at ordinary temperatures, and again dissolved, it will give the second spectrum. On the other hand, basic acetate of lead precipitates the chlorophyll unchanged.

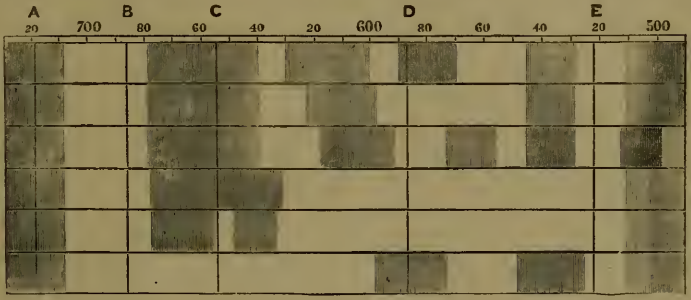


FIG. 1.
„ 2.
„ 3.
„ 4.
„ 5.
„ 6.

Acids, heat, metallic solutions, all action the chlorophyll, and all give rise to an identical spectrum, and therefore, we conclude, to the same body. Further, it is of interest to note the identity of these processes with those used to coagulate albumin, and consequently the probability that the change in both cases is of a similar character.

Since these changes are produced by processes and reagents which differ so materially, we are bound to conclude that the change is a molecular, not a chemical one. In these cases the least refrangible band does not alter, for if the solution be diluted, it always thins down to a band from 670 to 660; the other three bands, on the contrary, all change, the 628—607 moving towards the blue, the 589—573 band disappearing, and the 544—531 band becoming very much darker. In fact, although a shadowy indication of this last band is constantly visible in the normal solution, it is often so small in amount that it should be regarded rather as an accidental impurity than as a necessary part of the normal spectrum. Again, the essential and characteristic distinction between the two spectra, Figs. 2 and 3, is the presence in the latter of the band at 573—558. This band, as far as we know, is produced solely by the presence of a strong acid in considerable excess, and all specimens of chlorophyll, either normal or not, yield it on the addition of hydrochloric, nitric, or sulphuric acid.

There is obviously a considerable resemblance between these three spectra, but at present, notwithstanding the beautiful work of Abney and Festing, we can hardly deduce from these indications alone the nature and relationship between these bodies; but from the processes used for obtaining them, there can, we think, be little or no doubt that they are simply molecular modifications of the original chlorophyll, and we propose at present to designate them as α and β-chlorophyll.

With regard to the different purifying processes that have been used for obtaining chlorophyll from leaves, &c., in some cases the normal chlorophyll has been extracted; in others the leaves have first been dried at steam-heat, or the alcoholic solution has been boiled, and it is the α-chlorophyll that has been obtained. We have tried several of these processes, and, efficacious as they undoubtedly are in removing many, if not all, of the numerous bodies existing in more or less intimate connection with the chlorophyll, still they appear to produce really no change in the spectrum. With regard to general absorption, no doubt they do produce marked effects, specially at the blue end of the spectrum; this is well seen in the methods of purification recommended by Conrad. He obtained, as he believed, a separation of chlorophyll into a green and a yellow body by means of benzene. Observation shows, however, that the band-giving body, the chlorophyll, remains quite unchanged by the benzene, but that certain bodies which absorb in the blue are insoluble in this menstruum: hence the change in colour.

Hydrochloric acid has apparently considerable power of destroying certain of these blue-absorbing bodies, for on adding this acid to an ordinary chlorophyll solution, blue rays come through, where before the addition it was quite dark. This fact has also this application: by means of it chlorophyll can be obtained more free from blue-absorbing matter than in any other way we are acquainted with. If to an alcoholic chlorophyll solution dilute hydrochloric acid be added, a precipitate is obtained, and if this be washed, dried, and dissolved in ether or in a mixture of alcohol and ether, it gives a solution which shows, not only the bands of the α-modification, but also a band at the blue end of the spectrum, which was before alluded to, quite dark and distinct from 513 to 499. In all probability this band is present in other cases, but is masked by general absorption.

The action of alkalis on chlorophyll is quite as marked and as characteristic as the action of acids. On adding either an alcoholic or an aqueous solution of potash or soda to a chlorophyll solution, two effects are produced: one is the fading out of all except the least refrangible, the dominant band, and the other is the spread of this band towards the blue, extending from 674 to 628. The action of alkali does not, however, stop here, for if a considerable excess be present, another, and an exceedingly interesting change sets in the dominant band now from 674 to 628 dividing into two distinct bands,[1] one from 674 to 660, and the other from 646 to 632; then if sufficient alkali be present, the 674 to 628 band gradually becomes fainter and fainter, and ultimately the one from 674 to 628 alone remains. The same changes can be brought about with the α- and β-chlorophyll, but with far more difficulty. To change these varieties the potash or soda must be stronger, and the contact longer. With ammonia we believe we have broken this band up, but in almost all cases ammonia is without action on these modified chlorophylls, and it is quite clear that, as regards the action of alkalis, the α- and β-chlorophylls are far more stable than normal chlorophyll. There are other and more convenient methods for preparing this one-banded modification of chlorophyll. One is to evaporate an alcoholic solution of chlorophyll to dryness over a water-bath; then treat the residue with water, which washes out a soluble yellow substance, varying very much in amount with different samples of chlorophyll; and then evaporate the residue several times to dryness with a mixture of equal parts of ammonia and water. Another method is to act on the chlorophyll with a solution of copper sulphate; the precipitate formed is washed with water until all the copper is removed, then dried, and dissolved in alcohol and ether. It gives a spectrum identical with that obtained by the ammonia process, and like it the band is capable of being split up into two bands. In the filtrate from the above precipitate there is always much chlorophyll remaining, but this, curiously enough, has also been modified, and now gives only the one-band spectrum. When we first obtained this one-banded substance, the position of this band appeared so nearly to correspond with that of the dominant band in a strong solution, that we were inclined to believe that we had really separated the bodies giving the more refrangible bands, from those which give the less refrangible; but evidently this is not the case; neither does it now seem at all probable that such a separation would be possible.

We have used the term one-banded modification of the chlorophyll, and are aware of the possible ambiguity that this band can be split into two; but this change is really brought about only by the continued action of alkalis, for on simply diluting the solution down even to the vanishing point of the band, there is no indication of two bands being present.

The solution of this one-banded substance is still of a beautiful green colour, and is very remarkable for its stability; neither a trace nor an excess of acid of any kind produces any change in its spectrum, and it may even be dissolved in strong sulphuric acid and reprecipitated by water without alteration.

If the action of caustic potash or soda be pushed to an extreme, for instance if chlorophyll be heated with solid potash, then it is apparently completely decomposed, the dominant band disappearing, and two bands different in position from any of the former ones being produced; these are shown in Fig. 6.

To return now to the fact of different leaves giving different spectra; for instance, when vine-leaves are treated with alcohol and ether, the liquid gives strongly the α- not the normal spectrum. As is well known, the juices of the vine-leaf are very acid: consequently during the extraction of the colouring-matter, the acid has time and opportunity for action, and hence the cause of what appears at first to be an anomaly. In the leaf itself the chlorophyll is in the normal condition, for if to the bruised leaf precipitated calcium carbonate or carbonate of soda be added, together with the alcohol and ether, the filtered liquid then gives, not the α- but the normal spectrum; and even without the addition of the calcium carbonate, on rapidly extracting the colouring-matter from the leaf and examining it immediately, the spectrum is normal. It is therefore evident that although both chlorophyll and acid are present in the leaf, they are not under such conditions that they can act on one another; but bring them into solution, and the change commences immediately.

Virginia creeper, Bigonia, and other leaves, act exactly like the vine. The acid in the Bigonia can be entirely removed by water, and if the colouring-matter be then extracted, it gives the normal spectrum.

The way we now generally adopt in extracting the chlorophyll from leaves is to add with the alcohol and ether precipitated calcium carbonate; then, whether the juice of the leaf be very acid or not, is a matter of indifference. We have already stated that in all the different leaves which we have examined, the chlorophyll has been found to be in the normal condition. This applies of course only to freshly-gathered leaves; the chlorophyll in gathered leaves gradually changes, and passes over the α-modification, the time required for this change varying with the leaf and with external circumstances; whether the leaf be exposed to light, or kept in the dark, does not appear to affect the result. Pear leaves, after being gathered for three weeks and kept in a dry room, yielded both normal and α-chlorophyll; the change apparently had just begun. The chlorophyll in some vine leaves that had been gathered less than ten days had completely passed over to the α modification; but similar leaves, gathered at the same time and kept in water, gave only normal chlorophyll. Remembering how easily the solid normal chlorophyll passes over to the α-modification, it is evidently not necessary to suppose that the acid in the leaf is the cause of this change.

The chlorophyll having passed over to the α-modification, remains with wonderful pertinacity in the dead leaf. Dead pear leaves which had fallen from the tree seven months ago still gave a brilliant spectrum of α-chlorophyll, and even an alcoholic and ether extract of tobacco gives this spectrum.

The solutions of chlorophyll obtained by the direct treatment of leaves with alcohol and ether, contain a large number of substances, and the chlorophyll, as well as the other bodies, undergoes change on keeping. The length of time during which these solutions retain their green colour varies very much; expose them to light, and the rapidity of the change is enormously increased. If acid be present in the solution, the chlorophyll quickly passes over to the α-modification, and even if the extract has been made with calcium carbonate present, the same change occurs, only more slowly. These changes take place even in the dark. Besides this change of the chlorophyll, other and more complicated changes occur. Solutions from some leaves can be kept in the dark apparently without change for months, whereas others rapidly alter, and the chlorophyll disappears from them. The extract from rhubarb, for instance, very soon changes, the solution becoming of a tolerably bright red colour, and the chlorophyll bands disappearing. This red substance and the other products of decomposition from their solutions do not give visible spectra, and the same remark applies to at least the majority of the colouring matters in flowers. If these green solutions be exposed to light, they are, without exception, rapidly decomposed, and lose entirely their green colour, becoming either red, yellow, or of some intermediate shade. Brilliant sunshine in an hour or two will completely decompose all the chlorophyll in a dark green solution, not even a vestige of the dominant band remaining. If a solution of the α-chlorophyll, dissolved in alcohol and ether, be exposed to light, it is far more difficult of decomposition, and will withstand its action for a few days. That this stability is not due to the absence of certain substances in the solution of the α-modification, is shown by dissolving some of this modified chlorophyll in a normal and readily decomposable solution, when it will be found that, although there will be a change of colour

---

[1] Chautard, as long ago as 1836, mentions this; he naturally concludes that it is the original dominant band split up (*Compt. rend*, lxxvi. 570).

owing to the decomposition taking place in such a solution, still the green colour from the modified chlorophyll will long remain. A single drop of hydrochloric acid added to the green extract, although it at once changes the bright green to a darker and browner green, enables the solution to resist this action of light to a much greater extent than it could have done if no acid had been added.

In the one-banded modification of chlorophyll we appear to have a body on which light has no action; solutions of this body have been, for the last three months, exposed continuously to all the light and sunshine we could get, and they are unchanged in colour and constitution; another proof of the really wonderful stability of this substance. Again, as a confirmation of the properties and formation of this form of chlorophyll, a single drop of sulphate of copper added to an ordinary chlorophyll extract renders the green colour of the solution permanent.

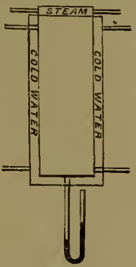
The very striking change of tint which occurs when a strong chlorophyll solution is very considerably diluted, whereupon it changes from a dark to a light yellowish green, forcibly suggests to us the probability that the difference in shade of old leaves as compared with young ones, is due to the same cause, namely, the greater or smaller amount of chlorophyll in a given area.

ON A METHOD OF INVESTIGATING EXPERIMENTALLY THE ABSORPTION OF RADIANT HEAT BY GASES[1]

THERE are grave objections, which have been only partially overcome, to almost all the processes hitherto employed for testing the diathermancy of vapours. These arise chiefly from condensation on some part of the apparatus. Thus when rock-salt is used, an absorbent surface-layer may be formed; and, when the pile is used without a plate of salt, the effect of radiant heat may be to cool it (the pile) by the evaporation of such a surface film. The use of intermittent radiation is liable to the same objection.

Some time ago it occurred to me that *this* part of the difficulty might be got rid of by dispensing with the pile, and measuring the amount of absorption by its continued effects on the volume and pressure of the gas or vapour itself.

Only preliminary trials have, as yet, been made. They were carried out for me by Prof. Mac-Gregor and Mr. Lindsay.



Their object was *first* to find whether the method would work well, *second* (when this was satisfactorily proved) to find the best form and dimensions for the apparatus.

The rough apparatus is merely a double cylinder, placed vertically. Cold water circulates in the jacket, and steam can be blown into the double top. The changes in the pressure of the gas are shown by a manometer U tube at the bottom, which contains a liquid which will not absorb the contents. This apparatus was 4 feet long, with 2 inches internal radius. The results of a number of experiments show that it should be shorter and much wider. The former idea I was not quite prepared for, the latter is obvious.

The effects on the manometer are due to five chief causes:—

1. Heating of the upper layer of gas by contact with lid.
2. Cooling " " " " " sides.
3. Heating of more or less of the column by absorption.
4. Cooling of do. by radiation.
5. " " contact.

(1) and (2) only are present in a perfectly diathermanous gas, and in a perfectly adiathermanous gas or vapour.

All five are present in a partially diathermanous gas or vapour.

The preliminary experiments show that the manometer effect is only *very slightly less* for dry olefiant gas than for dry air, while moist air shows a markedly smaller effect than either of the others.

This is conclusive as to the absorption of low radiant heat by aqueous vapour, but it shows also that the absorption is so small as to take place throughout the whole column.

Even with the present rude apparatus I hope soon to get a very accurate determination of the absorbing power of aqueous vapour, by finding in what proportions olefiant gas must be mixed with air to form an absorbing medium equivalent to saturated air at different temperatures.

I have to acknowledge valuable hints from Prof. Stokes, who, before I told him the results I had obtained (thus knowing merely the *nature* of the experiments) made something much higher than a guess) though somewhat short of a prediction, of the truth.

In these preliminary trials no precaution was taken to exclude *dust*. The results, therefore, are still liable to a certain amount of doubt, as Mr. Aitken's beautiful experiments have shown.

The *point* of the method is that there can be no question of surface layers.

[Since the above was written, Messrs. Mac-Gregor and Lindsay have made an extended series of experiments with dry and moist air, and with mixtures of dry air and olefiant gas in different proportions. The cylinder employed was 9 inches in radius. The results will soon be communicated to the Royal Society of Edinburgh.—P. G. T.]

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—In addition to the courses in Natural Science described in last week's NATURE, the following will be given during the present Michaelmas term:—Prof. Pritchard will give a course of six lectures on the Theory of the Transit Instrument, Equatorial, and Sextant, to be followed by six lectures on the Lunar Theory. There will be eight lectures on Instrumental Practice, and eight "Evenings with the Telescope," the latter being of a popular and untechnical character.

Prof. Lawson has announced the following courses of lectures for the ensuing year at the Botanical Gardens:—

Course I. Vegetable Histology; Michaelmas Term, 1882.

Course II. Special Morphology; Lent Term, 1883, and Trinity Term, 1883 (continued).

Course III. Descriptive Botany; every Saturday in Lent and Trinity Terms, 1882.

Prof. Prestwich gives a course on Theoretical Geology at the University Museum, and Prof. Westwood on Certain Groups of Anthropoda.

The Regius Professor of Medicine gives notice that an examination for certificates in Preventive Medicine and Public Health will be held this term, and secondly that Bachelors of Medicine may proceed to the degree of Doctor in any term, on due notice being given.

Natural Science Scholarships are offered this term at Balliol and at Christ Church.

The notice issued by Balliol College states there will be an election to a sholarship on the foundation of Miss Hannah Brackenbury, "for the encouragement of the study of Natural Science," worth 80*l*. a year (55*l*. and tuition free), tenable during residence for four years: open to all such candidates as shall not have exceeded eight terms from Matriculation. This examination will begin on Thursday, November 16, at ten o'clock. Papers will be set in the following subjects:—(1) Mechanical Philosophy and Physics; (2) Chemistry; (3) Biology. But candidates will not be expected to offer themselves in more than two of these. There will be a practical examination in one or more of the above subjects, if the examiners think it expedient. There will also be an optional paper in Mathematics; and the literary qualifications of the candidates will be tested by an English essay, or by a paper of general questions.

At Christ Church *at least* one scholar will be elected in Natural Science. Papers will be set in Biology, Chemistry, and Physics, but no candidate will be allowed to offer more than two of these subjects. An optional paper will be set in Elementary

---

[1] Letter from Prof. Tait, read by Sir W. Thomson at the Southampton meeting of the British Association.

Mathematics. Candidates will be tested in Classics, and required to show sufficient knowledge to pass Responsions. The emolument is 80*l.* annually. The examination begins on November 23. Candidates must not have exceeded the age of nineteen. The election in the first place is for two years. The tenure will be renewed for another two years if the College is satisfied with the progress and good conduct of the scholar. For special reasons the scholarship may be prolonged for a fifth year.

The formation of the new Boards of Faculties will not be proceeded with this term; it is proposed to defer the elections till a day not later than February 3, 1882. The appointment of examiners will therefore rest this term with the Vice-Chancellor and Proctors as before.

Prof. Max Müller has been elected a permanent Delegate of the Clarendon Press.

CAMBRIDGE.—Mr. James Ward is appointed Lecturer on the Science of Education at Cambridge for the present year; Mr. W. N. Shaw, of Emmanuel College, is approved as a teacher of Physics, and Mr. J. N. Langley, of Trinity College, as a teacher of Physiology for the purpose of Medical Studies.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, October.—Mohr's geographical theory of earth-pressure, by G. F. Swain.—The platinum-water pyrometer, by J. C. Hoadley.—Experiments on the fatigue of small spruce beams, by F. E. Kidder.—Theory of the stereoscope, by W. Leconte Stevens.—Report on European sewerage systems, &c. (continued), by R. Hering.—The manufacture of potash alum from felspar, by H. Pemberton, jun.—Report of the committee on the Fowler cloth-cutting machine.

Revue internationale des Sciences for September, 1882, contains: On the psychology and writings of Broca, by M. Zabrowski.—On the structure and on the movements of the protoplasm in the vegetable cell, by H. Frommann.—On orientation and its organs in man and animals, by M. Viguier.

SOCIETIES AND ACADEMIES

SYDNEY

Linnean Society of New South Wales, August 30.—The president, Dr. James C. Cox, F.L.S., &c., in the chair.—The following papers were read:—By the Rev. J. E. Tenison-Woods, F.G.S., &c., Botanical notes on Queensland, No. 4. This paper contained the author's observations on some of the Queensland species of *Myrtaceæ*, chiefly of the *Eucalypti*.—By the Rev. J. E. Tenison-Woods, F.L.S., &c., &c., on a coal plant from Queensland. This is an account of a fossil species of *Equisetum* found in the Ipswich coal beds, and provisionally named *E. rotiferum*, from the wheel-like shape of the diaphragm. No *Equisetum* had previously been found in the Australian coal beds.—By William Macleay, F.L.S., &c., Observations on an insect injurious to the vine.

PARIS

Academy of Sciences, October 16.—M. Jamin in the chair.—The following papers were read:—On the shock of two balls placed on a billiard table, by M. Resal.—On the catalogue of six hundred tornadoes observed in the United States in the course of this century, by M. Faye. This relates to a report by Sergeant Finley, of the U.S. meteorological service. The rapid increase of tornadoes recorded shows the rapidity with which population has increased. Trombes and tornadoes are short epiphenomena of cyclones. *Inter alia*, the mean velocity of gyration in a tornado is about 174 metres per second; the usual diameter is about 300 m. to 400 m.; the mean velocity of translation 17 m. per second. Most go from S.W. to N.E. They traverse about 11 leagues on an average, and last three-quarters of an hour. Several tornadoes may occur in one cyclone. They are formed exclusively in the dangerous semicircle of a cyclone, and nearly always a little in advance. They show a marked predominance in April, June, and July, and from 4 p.m. to 6 p.m.—On the functions of seven letters, by M. Brioschi.—Rational conception of the nature and propagation of electricity deduced (1) from consideration of the potential energy of ethereal matter associated with ponderable matter; (2) from the mode of production and transmission of work arising from variations of this energy, by M. Ledieu.—On the processes employed for the construction and plan of the metric standards, by M. Tresca. He has been unwell, but promises a complete memoir on the subject shortly.—Brazilian missions for observation of the transit of Venus, by M. Cruls. These are four in number, and will act at St. Thomas, Magellan, Pernambuco, and Rio de Janeiro, the respective heads being Capt. Jeffé, M. Cruls, M. Lacaille, and Capt. Jacques. Each station will have a 6-in. equatorial, a 4½-in. astronomical telescope, a meridian instrument with collimator, an excellent compensated pendulum, electric chronograph, &c. A chronometric junction of Magellan with Montevideo will be undertaken.—On the comet 1812 (Pons) and its approaching return, by MM. Schulhof and Bossert.—On the metric and kinematic properties of a sort of conjugated triangles, by M. Stephanos.—Ordinary and extraordinary indices of refraction of Iceland spar for rays of different wave length as far as the extreme ultra-violet, by M. Sarasin. The measurements referred to the principal lines of the visible solar spectrum and the lines of cadmium (induction spark) between two cadmium points). M. Soret's fluorescent ocular was used for the ultra-violet lines. The columns for the two prisms used show satisfactory agreement, as do also the author's values for the ordinary index for D and F with those of M. Mascart and M. Cornu.—The forces of induction which the sun develops in bodies by its rotation vary, all other things equal, in inverse ratio of the squares of the distances, by M. Quet.—On M. Helmholtz's theory of double electric layers; calculation of the magnitude of a molecular interval, by M. Lippmann. The interval ϵ he calculates to be 1-35,000,000 mm., which it is interesting to compare with the number, nearly the same (1-30,000,000) arrived at by Sir William Thomson by quite another way, for the minimum distance separating copper from zinc.—On the electrolysis of hydrochloric acid, by M. Tommasi. He examines the two cases of concentrated and dilute acid, platinum electrodes being used.—On the reduction of nitrates in arable land, by MM. Dehérain and Maquenne. Nitrates, in being reduced in arable land, liberate under certain conditions protoxide of nitrogen. The reduction occurs only in arable land containing much organic matter, and has been observed only when the atmosphere of the ground was absolutely free from oxygen.—On the industrial richness of crude alunite, in powder, by M. Guyot. The proportion of the base varies considerably (17·5 to 32 per cent.).—On chronic poisoning by antimony, by MM. de Poncy and Livon. A cat weighing 867 gr. at first was made to absorb, in a regular progressive way, 0·628 gr. of white oxide of antimony between April 26 and August 13. The animal did not pass through a period of embonpoint (as with arsenic), but it gradually fell into disease, took diarrhœa and died. All the tissues were pale and colourless, and nearly all the organs showed fatty degeneration.—Two maps of part of the Newfoundland coast, by Admiral Cloué, were presented.

CONTENTS